AMERICAN MUSEUM OF NATURAL HISTORY

Guide Leaflets No. 52-64
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52.	Osborn, H.F.	The Hall of the Age of Man Second Edition, Revised 1923
52.	Osborn, H.F,	The Hall of the Age of Man Third Edition, Revised and Enlarged, May 1925
53.	Lucas, F.A.	The Story of Museum Groups. Nov. 1921
54.	Coleman, L.V.	Plants of Wax. February, 1922
55.	Kroeber, A.L.	Basketry Designs of the Mission Indians. July, 1922
56.	Reeds, C.A.	The Geology of New York City and Vicinity (Reprinted from Natural History, Vol.22, pp. 1-15, 1922)
56.	Reeds, C.A.	The Geology of New York City and Vicinty. (Illustrations vary)
57.	Lucas, F.A.	Guide to the Hall of Mammals. Oct. 1923
58.	Chapin, J.P.	Preparation of Birds for Study. 1923
59.	Lucas, F.A.	The Preparation of Rough Skeletons.
60.	Matthes, F.E.	The Story of the Yosemite Valley. July 1924
61.	Anthony, H.E.	The Capture and Preservation of Small Mammals for Study. November 1925
62.	Osborn, H.F.	Mastodons and Mammoths of North America. (Reprinted from Natural History, Vol.23, no.1, and Vol. 25, no. 1, 1923, 1925)
63.	Wissler, C.	Indian Costumes in the Unites States... July 1926
64.	Lucas, F.A.	Meteorites, Meteors and Shooting Stars. 1926

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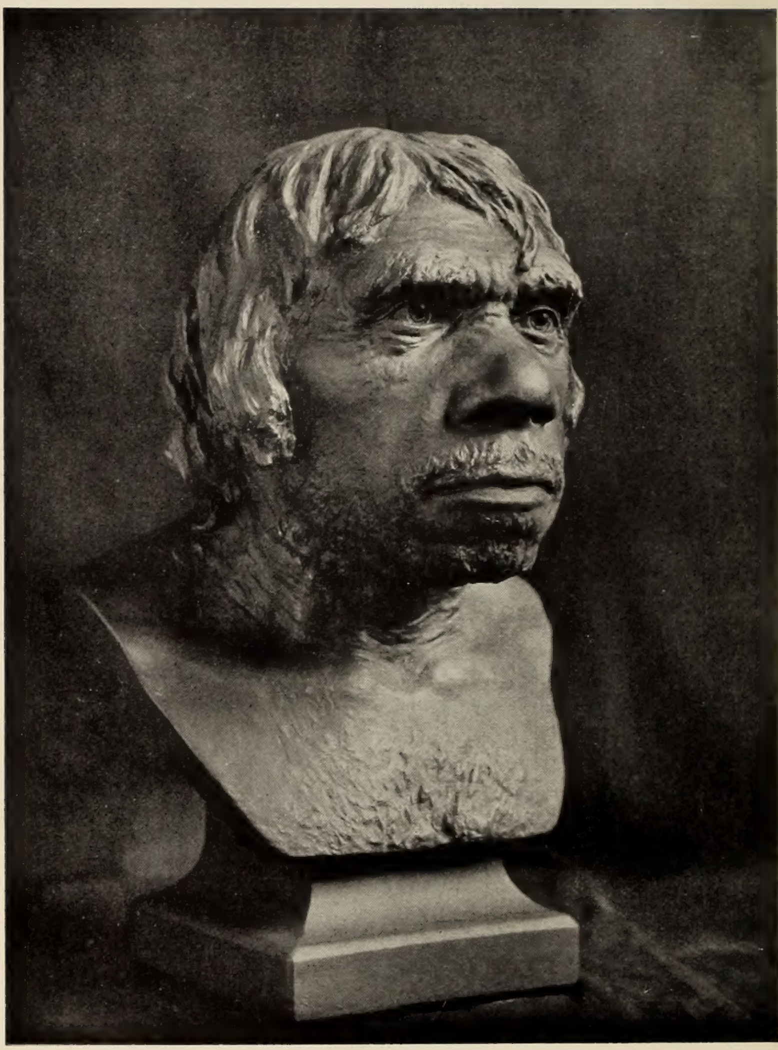
The HALL OF THE AGE OF MAN is designed to show *what we know of Man and his environment* during the long period of geologic time in which man rose from a condition of limited intelligence and subordination to the Animal World to his present condition of great intelligence and mastery both of the Animal World and of many of the principal forces of Nature.

The exhibit is arranged in an educational manner so as to present very simply, very truthfully, and very clearly, our actual knowledge, and not to confuse the visitor with theories or speculations.

The actual fossil remains of Man are represented by casts which are colored as nearly as possible to duplicate the originals which are to be found only in the great museums of Europe. Great pains are taken to secure casts of the very latest discoveries in various parts of the world. The beginning of this collection was a gift of Dr. J. Leon Williams in 1915, and it is constantly being amplified by gifts from other friends and from museums abroad.

The models and restorations and mural paintings of man and of the great mammals among which he lived and struggled represent the knowledge of more than a century of exploration and anatomical study by the leading students of Comparative Anatomy, Palæontology from the time of Cuvier in 1790 to the present period

2nd ed. rev.



Neanderthal Man

Modeled by Dr. J. H. McGregor on cast of skull found at La Chapelle aux Saints, France, in 1908.

TRINIL APE-MAN
Pithecanthropus erectus

NEANDERTHAL MAN
Homo neanderthalensis

CRÔ-MAGNON MAN
Homo sapiens

Fig. 1. THREE GREAT RACES OF PREHISTORIC MAN.
Models by Professor J. H. McGregor.

The Hall of the Age of Man in the American Museum

By HENRY FAIRFIELD OSBORN

Second Edition, reprinted, with additions and changes from *Natural History*, the Journal of the American Museum of Natural History, for May-June, 1920, pages 228–246.

The exhibits in the Hall of the Age of Man are intended to illustrate what is known of the origin, relationships and early history of man, as deduced from his remains and primitive implements, and also to show the animals by which he was surrounded in the early stages of his existence. These animals are shown not only as mounted skeletons but in a series of large mural paintings portraying them as they appeared in the flesh amid their natural surroundings. These paintings are the result of the study of their fossil remains and their careful comparison with related existing animals, a work to which the author has devoted many years of study. Hence they give an accurate and vivid idea of the animals that were the contemporaries of early races of man in various regions of the world.

A series of cases in the center of the hall are devoted to the story of man, and that it can be compressed into so small a space is an indication of the scarcity of his remains, for here are displayed reproductions of the most notable specimens that have been discovered. It has been necessary to use copies, for the actual specimens are few in number and scattered through many museums in widely separated parts of the world.

THE beginning of the Age of Man, some 500,000 years ago, roughly estimated as the close of the Age of Mammals, marks in reality but the beginning of the close of the Age of Mammals. The extinction of the most superb mammals that the earth has ever produced, during the early stages of human evolution, progressed from natural causes due directly or indirectly to the Glacial epoch. With the intro-

duction of firearms the destruction has proceeded with increasing rapidity, and today it is going on, by the use of guns and steel traps, at a more rapid rate than ever. By the middle of this century man will be alone amid the ruins of the mammalian world he has destroyed, the period of the Age of Mammals will have entirely closed, and the Age of Man will have reached a numerical climax, from which some statisticians believe it will probably recede, because we are approaching the point of the over-population of the earth in three of the five great continents.

Man as a Primate, Case I

A few of the more striking points of anatomical agreement between men and apes are illustrated in the first A case, which shows comparative series of skulls, lower jaws, brain-casts and teeth.

In this exhibit skulls of the great man apes (at the right in Case I) are placed for comparison with those of some of the known extinct or fossil races of man, each ascending along a line of its own. Copies of the most recent discoveries in various parts of the world are placed in this series; in fact, this entire exhibit is designed to show from time to time our progress in discovery, to present actual evidence in place of theories and speculations, and to show how very limited this evidence is as compared with the abundant evidence in the ancestry, for example, of the horse (shown in the hall of the Age of Mammals).

The Ascent of Man

Man has a long line of ancestry of his own, perhaps two million or more years in length. The cradle of the human race was, in our opinion, in Asia, in regions not yet explored by palæontologists. One reason that human and prehuman fossil remains are rare is that the ancestors of man lived partly among the trees and forests; this does not mean that they were arboreal; they lived chiefly on the ground.[1] Even when living in a more open country the ancestors of man were alert to escape the floods and sandstorms which entombed animals like the horse of the open country and of the plains. Hence fossil remains of man as well as of his ancestors are extremely rare until the period of burial began.

The earliest known human remains of the Trinil, Piltdown and Heidelberg races consist principally of portions of skulls, of jaws, and teeth. Individuals of the prehistoric races of Europe are now represented by casts in the Hall of the Age of Man. The museum series

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[[1]This refers only to the higher, more recent ancestors of man. The most thorough studies of the anatomy of the foot of man and other primates have brought strong support to the view that the human foot has been derived from an earlier ape-like stage in which the great toe could be used in climbing. W. K. G.]

MAN'S PLACE AMONG THE PRIMATES

1, skull of gibbon; 2, orang; 3, chimpanzee; 4, old male gorilla; 5, young gorilla; 6, *Pithecanthropus*, skull reconstructed by Dr. J. H. McGregor; 6, model of bust of *Pithecanthropus* by Dr. McGregor; 6, cast of original skull top of same; 7, Piltdown skull (*Eoanthropus*) reconstructed by Dr. McGregor; 8, Neanderthal (Chapelle-aux-Saints), cast of original; 9, Talgai (Australia) cast of original; 10, old man of Crô-Magnon, cast of original; 11, modern white skull.

The Heidelberg jaw (cast) is between 7 and 8. The other specimens are casts of various teeth and jaw fragments of fossil apes: *Propliopithecus* at the bottom, *Sivapithecus* at the left, and several species of *Dryopithecus* and allied genera at the right. The geologic ages (Oligocene, Miocene, etc.) are indicated by the horizontal zones. The black lines indicate the relationships as inferred by Dr. W. K. Gregory.

SKULL MODELS OF FOUR PREHISTORIC HUMAN TYPES

Reconstructions by Professor J. H. McGregor.

Dark parts represented in the original, light parts restored from other specimens.

1. Trinil Ape-Man (*Pithecanthropus erectus*), Upper Pliocene, Java. Showing a very low type of skull, with strong ape-like characteristics.

2. Piltdown Man (*Eoanthropus dawsoni*), Upper Pliocene (?), Sussex, England. Showing a distinctly higher type of skull; nevertheless, the brain cast is far inferior in the development of its parts to that of modern man. The jaw (of which the left side is preserved in the original) is of very low type, more ape-like than any other known human jaw.

3. Neanderthal Man (*Homo neanderthalensis*), Old Stone Age, Europe. The skull is of very large size but of low type, shallow in height, narrow in the frontal region; face very massive with wide nose and sloping chin.

4. Crô-Magnon Man (*Homo sapiens*), Late Old Stone Age, Central France. The skull is of high grade, with steep forehead, high vault and vertically straight face.

Fig. 2. *A*, *B*, *C*, *D*, skull fragments found by Dawson and Smith Woodward in 1911, 1912. *E*, jaw fragment found by Dawson in 1912. *F*, canine tooth found by Father Teilhard de Chardin in 1913. *G*, nasal bones found by Dawson in 1913. *H*, single worked flint found near original skull fragments by Smith Woodward. Jaw one-third natural size; other fragments a bit larger than one-third (distorted somewhat by camera).

Fi g 3. *A*, side and top views of jaw of first Piltdown man, with first and second lower molar teeth in place. *B*, side and top views of first lower molar tooth of second Piltdown man. About three-fourths natural size.

Fig. 4. The "Heidelberg jaw," found at Mauer, near Heidelberg, Germany. About one-third natural size.

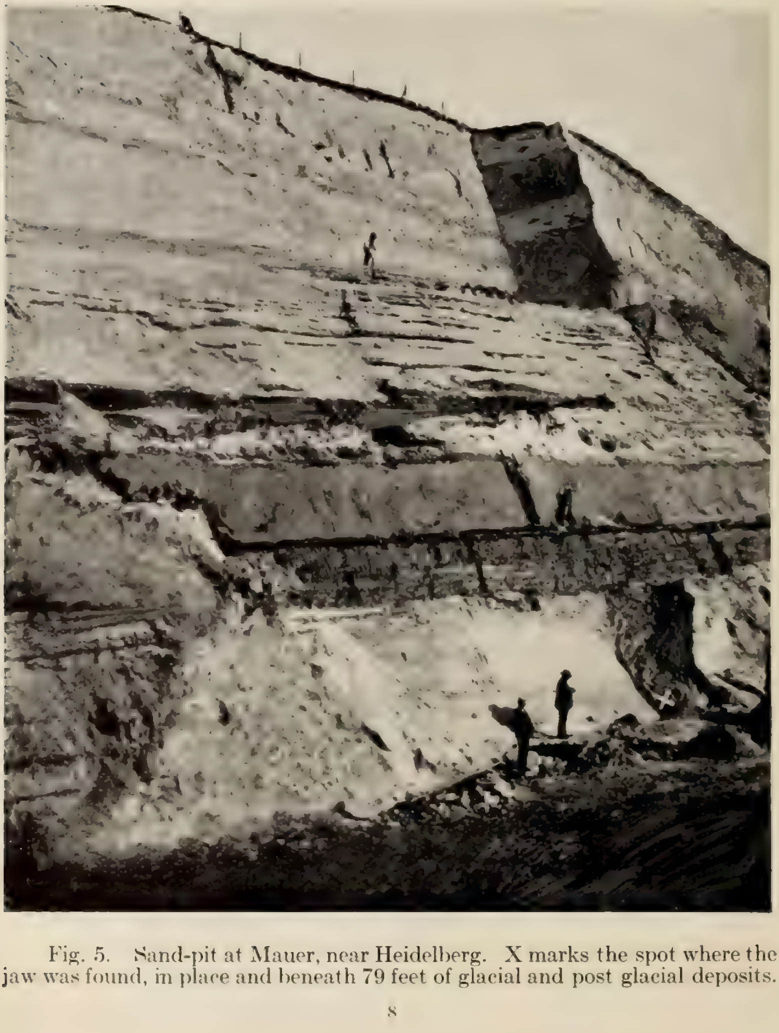


Fig. 5. Sand-pit at Mauer, near Heidelberg. X marks the spot where the jaw was found, in place and beneath 79 feet of glacial and post glacial deposits.

began in 1915 with the gift of the J. Leon Williams Collection, and has been enriched by additions from the museums of London, Paris, and recently by the Neanderthal man of Krapina, presented by Professor K. Gorjanovič-Kramberger, through the kindness of Col. C. W. Furlong; also the Talgai skull from South Australia, presented by Dr. Stewart A. Smith.

The earliest known man is the Foxhall man, known at present only by his flint implements, partly burned with fire, found near the little hamlet of Foxhall, near Norwich, on the east coast of England. These flints, discovered in 1921, constitute the first proofs that man of sufficient intelligence to make a variety of flint implements and to use fire existed in Britain at the close of the *Age of Mammals;* this is the first true Tertiary man ever found.

The Trinil ape-man, the *Pithecanthropus* of Java is the lowest of the known human or subhuman races. It is called ape-man because it is more human than ape-like. The restored head by Professor J. Howard McGregor, of Columbia University, is designed to show its half human, half anthropoid resemblance, as suggested by the top of the cranium, the only part known, which is far more human than that of any ape cranium, and at the same time far more ape-like than that of any human cranium. It is not impossible that this ape-man is related to the Neanderthal man.

The Most Ancient Human Races, Piltdown and Heidelberg

A few deep brown fragments of a skull and jaw and one tooth represent all the remains known of the Piltdown man, discovered in England by Charles Dawson in 1912. Several reconstructions of the Piltdown skull have been made, including the original by Professor A. Smith Woodward in London, in the British Museum, another, in this country, by Professor McGregor. The problem whether the Piltdown jaw belongs to this human skull or whether it belongs to a fossil chimpanzee is now actually settled, because a *second* specimen of the Piltdown man has been found two miles from the first in the same Piltdown gravels; this specimen has the same kind of lower grinding teeth and the same form in the bone of the forehead. The skull itself is of a primitive human type, the brain cast showing a lowly development of the higher cerebral association centers (Elliot Smith 1922).

Unquestionably the next most ancient human relic which has thus far been discovered is the jaw of the so-called Heidelberg man, a fossil which may be 250,000 years old. It is notable for its great size and for its lack of a protruding bony chin. The Heidelberg man may be ancestral to the Neanderthal man.

MEN OF THE OLD STONE AGE. THE NEANDERTHAL RACE OF EUROPE

Represented by casts of the original specimens and by models by Professor J. H. McGregor.

1. Skull top and femur of the type specimens of this race, discovered in the Neander Valley, near Düsseldorf, Germany, in 1856.
2. Skull top, and 3, skull top and jaw from Spy, Belgium.
4. Completed bust, and 5, half-head, half-skull model of Neanderthal Man.
6. Reconstructed skull of the old man of La Chapelle-aux-Saints (Dordogne, France).
7. Original condition of same.
8. Skull of youth found at Le Moustier, Dordogne, France.
9. Jaws from Malarnaud, France.
10. Jaw fragments, etc., from Krapina, Croatia.

Painted by Charles R. Knight under the direction of Henry Fairfield Osborn. Copyrighted photograph.

THE NEANDERTHAL FLINT WORKERS (MURAL I)

The Neanderthal Race

The Neanderthal man represents the oldest fossil human race of which the skeleton is fully known. The remains are very abundant, and the American Museum owns reproductions of many skulls and parts of skulls found during the last half century in Spain, Germany, France, and Hungary. Foremost of these is the skullcap found near Düsseldorf, Germany, in 1856, which constitutes the type of the Neanderthal race itself.

Of great interest is the reconstruction by Professor McGregor of a Neanderthal female head, based upon a skull found at Gibraltar in 1848, which gives us the head characters of the women of this very primitive race.

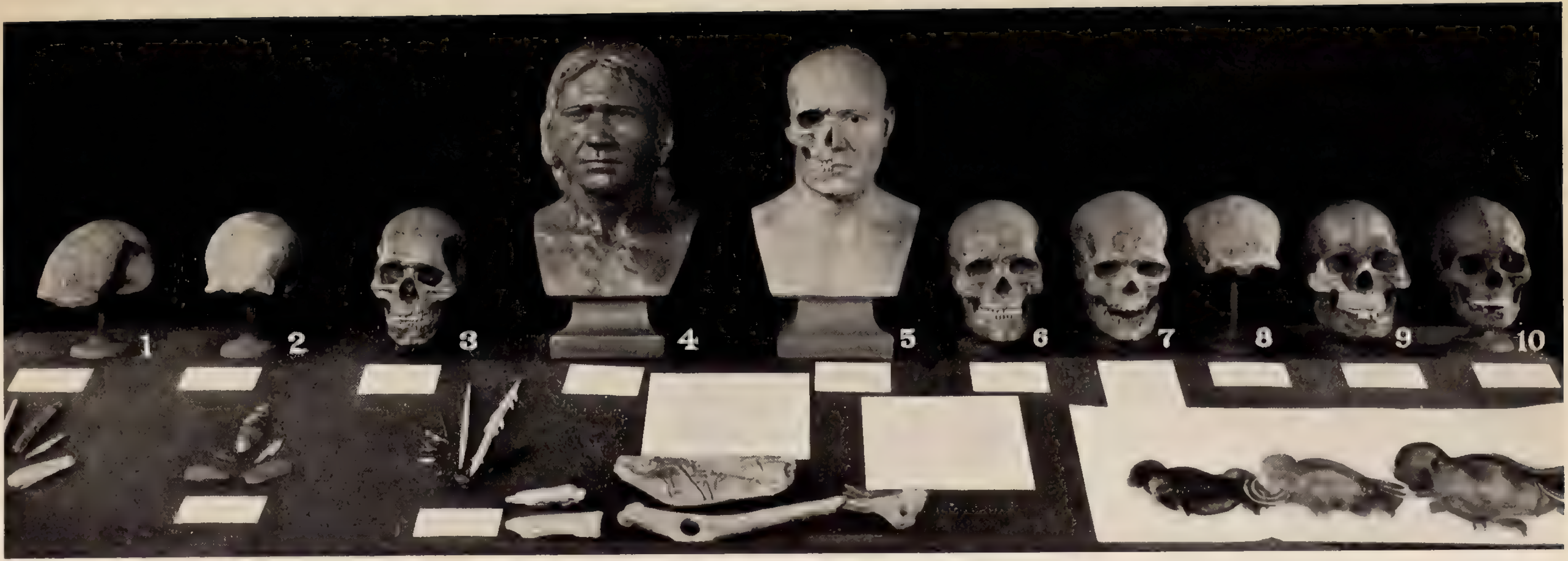
Nearly perfect is the skull from La Chapelle-aux-Saints, originally restored by Professor Marcellin Boule, of Paris, and reconstructed by Professor McGregor; this distinguished American expert in the anatomy of palæolithic man is now engaged upon the reconstruction of the entire skeleton and body of the Neanderthal man. This life-sized Neanderthal model will be one of themost interesting exhibits in the American Museum; it represents many years of laborious study and research by Professor McGregor, who was sent by the Museum on a special tour through Europe to examine all the known fossil remains of the Neanderthal race, representing forty or fifty individuals altogether, including the last specimen to be found, that of La Ferrassie, France, which is now being described by Dr. Boule.

The Rodesian Race

The most recent discovery is the Rhodesian man, *Homo rhodesiensis*, made in 1921, in a cave at the Broken Hill Mine, northern Rhodesia, Africa, where the human remains were found in association both with stone and bone implements, and with broken bones of animals which had evidently been used as food. This man was in the Stone Age of industry, using scrapers and knives of quartz and quartzite. The forehead is very low and the ridges above the orbit are excessively prominent; the opening for the nose was very wide, but the palate and teeth are like those in existing races. The brain is of a very low human type of the capacity of 1,280 c.c. (see Smith Woodward's *Guide*, pp. 29–31).

The Neanderthal Flint Workers (Mural I)

The mural of the Neanderthal group of flint workers shows in the distance, along the Dordogne River, herds of woolly rhinoceroses. The center of interest is the flint industry, which, with the chase, occu-



MEN OF THE LATE PALÆOLITHIC (OLD STONE AGE) OF EUROPE. THE CRÔ-MAGNON AND OTHER RACES OF HIGH TYPE.

1. Skull top found at Galley Hill, England. Cast of original.
2. Skull top (cast) found at Brünn, Moravia.
3. Combe Capelle skull (cast) found near Montferrand, France.
4. Completed bust, and 5. Half-head, half-skull model of Crô-Magnon man.
6. Skull (cast) of type specimen, with teeth and some missing parts restored from study of other skulls of this race.
7. Skull (cast) of type specimen, one of five individuals found at Les Eyzies, Dordogne, France.
8. Skull top (cast) found with type specimen at Les Eyzies.
9. Skull (cast) of man discovered with other parts of skeleton at Obercassel, near Bonn, Germany.
10. Skull (cast) of woman discovered with other parts of skeleton at Obercassel, near Bonn, Germany

Painted by Charles R. Knight under the direction of Henry Fairfield Osborn. Copyrighted Photograph.

CRÔ-MAGNON ARTISTS PAINTING THE MAMMOTH (MURAL II)

pied the entire energy of the Neanderthals. Since the Neanderthal type is totally different from any modern human type, it must be studied from models of its own. The group is very carefully arranged to show the physical characters of this man: the knees slightly bent in the peculiar standing posture, the broad, heavy shoulders, slightly stooped, and the massive neck and the head set well forward. In the background is the famous cavern of Le Moustier, which gives its name to the Mousterian period of flint industry pursued by the Neanderthals.

The Crô-Magnon Race of High Type

The highly evolved Crô-Magnon race entered Europe from the east and drove out the Neanderthals. The Crô-Magnons were people like ourselves in point of evolution, and the characters of the head and cranium reflect their moral and spiritual potentiality. This was a race of warriors, of hunters, of painters and sculptors far superior to any of their predecessors. The contrast between the Crô-Magnon head and those of the Neanderthals which precede them is as wide as it possibly could be. It is intellectual and thoughtful.

Crô-Magnon Artists Painting the Mammoth (Mural II)

One of the recent murals in the hall of the Age of Man (over the doorway opposite the Crô-Magnon exhibit) represents four of the Crô-Magnon artists actually painting the great fresco in the cave of Font-de-Gaume, Dordogne, France. The writer has been studying the composition of this group for years, with Mr. Charles R. Knight, artist, aided by advice of the Abbé Henri Breuil of the Institut de Paléontologie Humaine, Paris, as well as of Mr. N. C. Nelson, archæologist at the American Museum of Natural History.

There are six figures in the group; four are depicted partly nude to show their anatomy in contrast with that of the Neanderthals. The two half-kneeling figures are holding up small lamps to illuminate the smooth surface of the limestone wall on which the procession of mammoths is being depicted. The half-erect figure represents an artist with pointed flint incising the outlines of a mammoth on the wall. The fully erect central figure represents an artist laying on the colors. A kneeling figure is preparing the colors on a rock. This design enables the painter to show the tall, slender proportions of the men of this Crô-Magnon race. The standing figure to the left is that of a chieftain clothed in well-made fur garments, who carries on top of his staff his *baton de commandement* as the insignia of his rank. The only illumination is that of the flickering wicks in the small oil lamps.

Men of the New Stone Age

Men of the Neolithic, or New Stone Age, continued to used chipped stone implements, but unlike their predecessors, they often polished them. They were the direct forerunners of civilization. They cultivated the ground, raising cereals, and had domesticated cattle and other animals; they made pottery and wove textiles; they lived in villages of huts, often built on piles near the shores of lakes. They erected sepulchres and temples of huge stones (dolmens, megaliths).

The Neolithic Stag Hunters (Mural III)

This mural group also is in its place in the hall (at the west end), having been completed in 1919. It represents men of the Nordic race, brown- or fair-haired, hunters of the stag, living along the southern shores of the Baltic in the earliest stage of the New Stone Age, a stage known as the Campignian from remains of huts and rudely polished stone implements found near Campigny in France. The scene is on the border of one of the northern beech forests and represents the return from the hunt. After the ardor of the chase the hunters have thrown off their fur garments. The chieftain in the center is partly clad in furs; in the coming winter season he will be wholly fur clad. His son, a fair-haired youth with a necklace of bear claws, grasps a bow and arrow and holds in leash a wolf dog, ancestor of the modern sheep dog of northern France. The hunters, with spears tipped with stone heads, are resting from the chase. Two vessels of pottery indicate the introduction of the new ceramic art, accompanied by crude ornamentation.

This race was courageous, warlike, hardy, but of a lower intelligence and artistic order than the Crô-Magnons; it was chiefly concerned, in a rigorous northern climate, with the struggle for existence, in which the qualities of endurance, tribal loyalty, and the rudiments of family life were being cultivated. Rude huts take the place of caverns and shelters, which are now mostly abandoned.

These were tall men with high, narrow skulls, related to the existing Nordic race, more powerful in build than the people of the Swiss Lake Dwellings. Skulls and skeletons representative of this hardy northern type are abundantly known in Scandinavia, but have not found their way to our American Museum collections as yet.

The Great Fossil Mammals Contemporaneous with and Hunted by Man

The hall of the Age of Man contains four chief collections of the mammals of the world during the period of the Age of Man. In Europe man hunted the reindeer, the wild horses and cattle, and the mammoth. He used the hide of the reindeer for clothing, the flesh and marrow for food. He carved the bones as well as the ivory tusks of the mammoth.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph.

STAG HUNTERS OF THE NEW STONE AGE (NEOLITHIC) (MURAL III)

Men of the Nordic race, brown- or fair-haired, living along the southern shores of the Baltic in the earliest stage of the New Stone Age.

The mammoth, the northern, hairy type of elephant known to early explorers of fossil remains, was foremost among the great mammals hunted by man. The previous history of the proboscidean order is also shown in the Hall of the Age of Man.

This is one of the romances of evolution quite equal in interest to the evolution of the horse. This collection is by far the most complete in existence; it contains as much in the way of complete skeletons as those in all the other museums of the world combined. The early stages in the evolution of the proboscideans, beginning with the *Palæomastodon* discovered in the Fayûm region of northern Africa, carry us back into times far antecedent to the Age of Man, namely, into an early period of the Age of Mammals, the Oligocene. Thus the visitor can see here the entire history of the evolution of the proboscideans, which taken altogether is the most majestic line of evolution that has thus far been discovered. The evolution of the proboscideans culminates in the mastodons and mammoths.

The Four Seasons in the Glacial Epoch (*Murals IV-VII*)

The four great murals on the north walls of the Hall of the Age of Man represent scenes during the four seasons of the year near the close of the Glacial epoch in the Northern Hemisphere.

These four seasons belong in the same period of geologic time, namely, the final glacial stage, the period of the maximum advance of the glaciers over the entire Northern Hemisphere, of the most intense cold, and of the farthest southward extension of the northern types of mammals. This is the time of the Crô-Magnon race, and our knowledge of the mammals, reindeer, and rhinoceroses is derived from the actual Crô-Magnon paintings and etchings, chiefly those found within the caverns. The murals of the four seasons are as follows:

IV. *Midwinter.*—The woolly rhinoceros in northern France.
V. *Early Winter.*—The reindeer and mammoth on the river Somme, France.
VI. *Midsummer.*—The mastodon, royal bison, and horse on the Missouri River, in the latitude of Kansas.
VII. *Autumn.*—The deer-moose, tapir, and giant beaver, in northern New Jersey.

Glacial Midwinter in Northern France (*Mural IV*)

The woolly rhinoceros, like the woolly mammoth, was heavily enwrapped in hair, beneath which was a thick coat of fine wool. With this protection the animal was quite indifferent to the wintry blasts which

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph.

THE WOOLLY RHINOCEROS IN A GLACIAL WINTER, NORTHERN FRANCE (MURAL IV)

swept over the steppe-like country of northern France. This golden-brown wool is actually preserved on the side of the face of one specimen discovered, which is now in the Museum of Petrograd. The head of the rhinoceros was long and narrow, like that of the white rhinoceros of Africa, but the jaws were narrower and the upper lips were more pointed. It is an animal quite distinct from the great black rhinoceros still extant in Africa, which is a grazer with broad lips. In the distance in the painting are shown the saigas, antelopes which wandered over France at that time, and a group of woolly mammoths.

Early Winter Scene on the Somme River in Northern France (*Mural V*)

The scene represents the two herds, reindeer and mammoth, migrating southward from the banks of the river Somme. These reindeer and mammoths are, in fact, depicted very precisely in the paintings and engravings left by the Crô-Magnon artists—especially in the cavern of Font-de-Gaume. It is a striking fact that, in the case of the mammoth, every painting, drawing, etching, and model which the Crô-Magnon man has given us exhibits exactly the same characters: the long hairy covering, the very high hump above the forehead, the notch between the hump and the neck, the very high shoulders, the short back, the rapid slope of the back over the hind quarters, the short tail. There is no doubt that, aided by these wonderful Palæolithic designs, the artist, Mr. Knight, has given us a very close representation of the actual appearance of the woolly mammoth.

Midsummer on the Missouri (*Mural IV*)

The summer scene on the Missouri River (on the parallel of Kansas) represents the region south of the farthest advance of the ice sheet. The mastodons are grouped in such a manner as to show the characteristic low, flattened head, the long low back, the symmetrical fore and hind quarters, the extremely short, massive limbs, and the very broad and massive hip region as seen from behind. In the center of the picture stands the majestic *Bison regius*, the royal bison, known only from a skull, a superb specimen with the horn cores attached, in the collection of the American Museum. These animals were like gigantic buffalo or bison, beside which the modern buffalo would appear very diminutive. The characters of the hair and wool are not known, but it is assumed that they were similar to those of the existing buffalo, since the paintings of the bison by the Crô-Magnon artists in France all show the distinctive beard below the chin. At the right is a group of wild American horses of the period, the last of their race in this country; the species is *Equus scotti*, the skeleton of which has been discovered in northern Texas.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph.

THE REINDEER AND MAMMOTH ON THE RIVER SOMME, FRANCE (MURAL V)

These animals were abundant in Europe in the cold dry climate, south of the great slowly retreating ice-sheet of the "Fourth Glaciation." They were hunted and accurately depicted by the Crô-Magnon artists.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph.

THE MASTODON, ROYAL BISON AND HORSE ON THE MISSOURI RIVER, IN LATE GLACIAL TIMES (MURAL VI)

South of the farthest advance of the ice sheet the mastodon lived in the forests of the east, while giant bisons and wild horses roamed on the plains of the west. Many occurrences of fossil human bones have been reported in North America, but none have yet been proven to be older than the latest glacial times.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn.] *Copyrighted photograph.*

THE MASTODON

This distant relative of the elephants may have been a contemporary of early man in the closing phases of the period of the glaciers, in North America.

Painted by Charles R. Knight, under the directio of Henry Fairfield Osborn. Copyrighted photograph.

THE WOOLLY MAMMOTH

This great elephant was characteristic of the latter part of the period of the glaciers in Europe. He was unted by the Crô-Magnons.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph.

AUTUMN IN NORTHERN NEW JERSEY DURING LATE GLACIAL TIMES (MURAL VII)

The deer-moose (*Cervalces*) was an extinct species of deer combining characters of the deer and of the moose; the tapirs (center), are related to those now found in Central and South America; the giant beaver (right) is now extinct.

Early Autumn in New Jersey (Mural VII)

The autumn scene in northern New Jersey embraces three very distinctive North American types of the period, all of which have become extinct. The deer-moose, *Cervalces* (to the left), was described by Professor W. B. Scott, of Princeton, from a single skeleton found in the gravel beds of northern New Jersey, which is now preserved complete in the Princeton Museum. The American fossil tapir (in the center) is known from sparse remains, the best of which were among the earliest discoveries of the pioneers of American palæontology. The giant rodents of the genus *Castoroides* (see two individuals at the right in the painting) are known from nearly complete skulls and skeletons discovered in Ohio and other central western states.

The Tar Pools of Southern California (Mural VIII)

This mural represents a scene in southern California, in the vicinity of the Rancho-la-Brea deposits, including the remains of the astonishing group of animals caught in the asphalt trap, so splendidly represented in the collection of the Museum of History, Science, and Art, of Los Angeles.

The most characteristic animals of North and South America that lived during the Age of Man (see the south side of the hall) are known through some of the unique remains from the famous deposits of Rancho-la-Brea of southern California, especially the sloths, saber-toothed tigers, and wolves of the period—to which it is hoped that we may add some of the less abundant forms, like the camel and the horse. So far as possible, through exploration and exchange, this quarter section of the hall will represent the mammalian life of North America, in contrast with the mammalian life of South America during the same period of time.

A Loess Storm on the Pampas of Argentina (Mural IX)

A mural on the western wall (at the left) of the Hall of the Age of Man presents a South American scene during the Old Stone Age. It depicts the ancient pampas of Argentina with the winding river La Plata in the background, and a typical extinct mammalian fauna. In the distance at the right a violent dust storm is transporting columns of fine, impalpable dust known as loess.

The Museum is extraordinarily rich in the great Pampean Collection presented by certain of the trustees in 1899. This collection shows the close connections between North and South America in glacial times.

One of the most wonderful fossil groups in the Museum, if not the most wonderful, is the sloth and glyptodont group (center of southern side of the Hall of the Age of Man). This group is still in preparation.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph.

THE DEATH-TRAP OF RANCHO LA BREA, CALIFORNIA (MURAL VIII)

Animals gathered around a "tar-pool" or asphalt pit. Giant condors, sabre-tooth tigers and ground sloths (*Mylodons*) in the foreground; wolves and mammoths in the background. Attracted by the water on the surface, one of the sloths is becoming mired in the treacherous pit. The scene respresents the abundant animal life of Southern California during the latter part of the glacial times, when the eastern states and northern Europe were covered by great ice sheets.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph.

A LOESS STORM ON THE PAMPAS OF ARGENTINA (MURAL IX)

The glaciers which covered so much of the northern hemisphere with a vast ice sheet during the Age of Man, were only locally developed in South America and never invaded the pampas of Argentina. Here lived a great assemblage of strange mammals, whose remains were often buried in the storms of fine dust (loess). The scene depicts in the foreground two giant ground sloths (*Mylodon*, *Lestodon*) and three glyptodonts; at the left a couple of toxodons are quietly browsing, while at the right are some of the slender-limbed Macrauchenias.

It includes five sloths of three varieties (the *Mylodon, Lestodon* and *Scelidotherium*) and three glyptodonts. These animals, so entirely different in external appearance and habits, nevertheless belong to the same order of mammals, the Edentata, which, as its name implies, is distinguished by the absence of enamel on the teeth. It is important to bring these two animals together in the same exhibit, so as to show the very wide contrasts in adaptation which may occur within the limits of a single mammalian order: the sloths covered with long hair and with vestiges of armature embedded in the skin, the glyptodonts nearly hairless, and encased in powerful bony armature, which renders them completely immune to attack by the saber-toothed tiger of the period.

Appendix

The Family Tree of Man

By William K. Gregory

Man is no doubt vastly superior to his distant relatives the anthropoid (man-like) apes. His brain and mind are on far higher levels of development, he walks erect, he is able to speak. Man has a long line of ancestry of his own, extending for perhaps two million years or more, far back into the Age of Mammals.

Yet the science of comparative anatomy has revealed the fact that man is constructed upon the same general anatomical plan as that of his more backward relatives, the gorilla and the chimpanzee, and that he is connected with them by a very large number of anatomical marks of distant kinship. The common plan, with differences in detail, upon which man and the great apes are constructed, becomes more and more evident and indisputable as our practical knowledge and experience of human and comparative anatomy increase.

The science of comparative anatomy, in combination with the science of palæontology, has provided the basis for the exhibit called "The Family Tree of Man," which is an attempt to present in a simple graphic form what is accepted by the best scientific authorities.

The Primates first became distinguishable from other orders of mammals very early in the Age of Mammals, that is, some three million years ago, according to the most conservative estimate. The first Primates were already adapted for living in trees and had grasping hind feet, but as may be judged from their small crania, they were greatly inferior in brain development to their modern descendants. This stage of evolution is represented in the exhibit by a cast of the skull of an extinct primate, *Notharctus osborni*, from the Middle Eocene of northwestern Wyoming.

The next two stages of ascent are so far known only from two small lower jaws dating from the Lower Oligocene of Egypt. In the first of

these, *Parapithecus*, the lower jaw and dentition are intermediate in character between the Eocene tarsioid primates and the oldest anthropoid. In the second jaw (*Propliopithecus*) the number and position of the teeth and the form and detailed arrangement of the cusps of all the teeth are exactly such as would be expected in the common starting point for the divergent lines leading to the gibbons, to the higher apes and to man.

In the long ages of the Miocene epoch (which is at the beginning of the second half of the Age of Mammals) there was a great branching out into different lines on the part of the primitive anthropoid stock, some of which began to foreshadow the modern gorillas and chimpanzees, while others (e.g., *Sivapithecus*) showed certain pre-human characters in the jaw and molar teeth.

By the latter part of the Age of Mammals the pre-human stock had probably become broken up into several distinct species, some of which were more backward, others more progressive toward higher types. The most backward of these early pre-human races was the *Pithecanthropus* or Ape-man, from the Upper Pliocene (late Age of Mammals) or Lower Pleistocene (early Age of Man) of Java. The top of his skull is strongly reminiscent of the apes and indeed it was long debated whether *Pithecanthropus* was a progressive ape, or a primitive man; but the imprint of the frontal lobes of the brain on the inside of the skull show that he was an extremely primitive man, perhaps ancestral to the Heidelberg and Neanderthal races.

The Dawn Man (*Eoanthropus*) of the Upper Pliocene, or Lower Pleistocene of England, had a more progressive type of brain case than that of *Pithecanthropus*, but his lower jaw was very ape-like, lacking a bony chin.

The Heidelberg jaw (Lower Pleistocene age, Germany), although already definitely human, is probably several hundred thousand years old. The jaw is of great size, with retreating chin and primitive human teeth.

The Neanderthal Race occupied Europe in the latter part of the Glacial period. The head is large, but the forehead is low, with strongly projecting brow ridges.

The Crô-Magnon race occupied Europe in the closing stages of Glacial times. It was in a high stage of evolution and belongs with modern races of man in the species *Homo sapiens*.

The Australian aboriginals represent one of the most primitive of the surviving races of man. They are probably distantly related to the most primitive peoples of India and to the early stock of the white races.

The detailed relationships of the other races of men are illustrated in special exhibits in the Introduction to Anthropology, now on the second floor, extreme west tower.

Fig. 6. The progress of primitive man as shown by his tools and weapons.

A. IMPLEMENTS TYPICAL OF THE EARLY PALEOLITHIC AGE

1. Hand-ax or chopping tool of flint.
2. Dagger or perforating tool of flint.
3. Implement of flint for various purposes, such as cutting and scraping.

B. IMPLEMENTS AND ORNAMENTS TYPICAL OF THE LATE PALEOLITHIC AGE

1. Knife blade or spear point of flint.
2. Knife or etching tool of flint.
3. End scraper or planing tool of flint.
4. Harpoon point of bone.
5. Lance point of bone.
6. Beads or pendants of elk teeth.
7. Beads of univalve shells.
8. Fragment of bone with partial outline of a horse etched upon it.
9. Fragment of bone with traces of geometric ornamentation.

Fig. 7. The progress of primitive man as shown by his tools and weapons (continued).

IMPLEMENTS TYPICAL OF THE NEOLITHIC AGE

1. Ax-hammer of stone, perforated for hafting.
2 Ax of flint, partly polished.
3. Saw of flint, one edge notched.
4. Dagger of flint, probably in imitation of metallic form.
5. Knife or sickle blade of flint.
6. Arrow point of flint, also made in larger sizes and used as spear points.

STONE CULTURES		HUMAN RACES	CONTEMPORARY MAMMALS
HISTORICAL		PERIOD	EXISTING MAMMALS
NEOLITHIC		PERIOD	MASTODON(?)MAMMOTH
AZILIAN MAGDALENIAN SOLUTRIAN	PALEOLITHIC	GRENELLE CRÔ-MAGNON	
AURIGNACIAN		GRIMALDI	REINDEER
COLD MOUSTERIAN		NEANDERTHAL	MAMMOTH WOOLLY RHINOCEROS
WARM MOUSTERIAN			ELEPHAS ANTIQUUS HIPPOPOTAMUS
COLD ACHEULEAN			
WARM ACHEULEAN		KRAPINA	
LATE CHELLEAN		EHRINGSDORF	
CHELLEAN			ELEPHAS ANTIQUUS HIPPOPOTAMUS
EARLY CHELLEAN			
		HEIDELBERG	ELEPHAS ANTIQUUS RHINOCEROS ETRUSCUS HIPPOPOTAMUS SABRE-TOOTH
CROMERIAN		PILTDOWN?	ELEPHAS PRIMIGENIUS MUSKOX REINDEER
FOXHALLIAN			

Fig. 8. Sequence of Old Stone Age (Paleolithic) in Europe.
The order in which the races of primitive men appeared in Europe and the most striking mammals living at the same time.

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THE AMERICAN MUSEUM OF NATURAL HISTORY

THE HALL OF THE AGE OF MAN

By HENRY FAIRFIELD OSBORN

GUIDE LEAFLET SERIES No. 52

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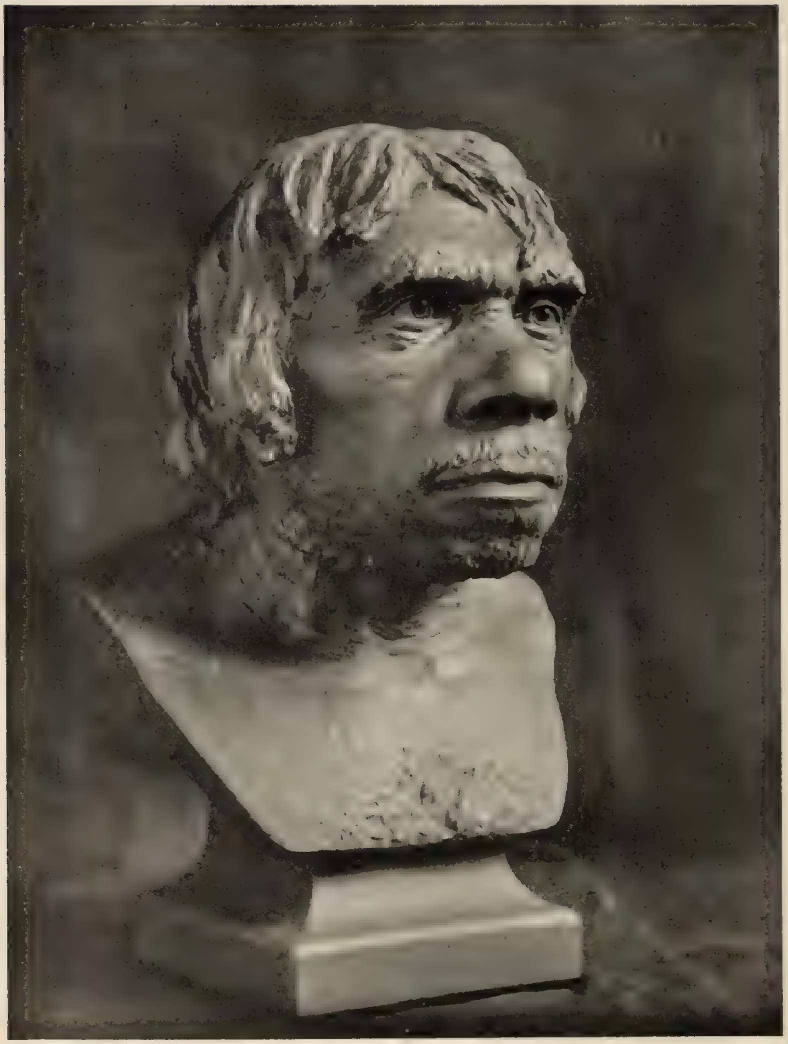


NEANDERTHAL MAN

Modeled by Dr. J. H. McGregor on cast of skull found at La Chapelle aux Saints, France, in 1908.

THE HALL OF THE AGE OF MAN

By HENRY FAIRFIELD OSBORN

Third edition revised and enlarged. Edited by William K. Gregory

THE AMERICAN MUSEUM OF NATURAL HISTORY
Guide Leaflet No. 52
May, 1925

The HALL OF THE AGE OF MAN is designed to show what we know of Man and his environment during the long period of geologic time in which man rose from a condition of limited intelligence and subordination to the Animal World to his present condition of great intelligence and mastery both of the Animal World and of many of the principal forces of Nature.

The exhibit is arranged in an educational manner so as to present very simply, very truthfully, and very clearly, our actual knowledge, and not to confuse the visitor with theories or speculations.

The actual fossil remains of Man are represented by casts which are colored as nearly as possible to duplicate the originals which are to be found only in the great museums of Europe. Great pains have been taken to secure casts of the latest discoveries in various parts of the world. The beginning of this collection was a gift of Dr. J. Leon Williams in 1915, and it is constantly being amplified by gifts from other friends and from museums abroad.

The models and restorations and mural paintings of man and of the great mammals among which he lived and struggled represent the knowledge of more than a century of exploration and anatomical study by the leading students of Comparative Anatomy and Palæontology from the time of Cuvier in 1790 to the present period.

TRINIL APE-MAN | NEANDERTHAL MAN | CRÔ-MAGNON MAN
Pithecanthropus erectus | *Homo neanderthalensis* | *Homo sapiens*

Fig. 1. THREE GREAT RACES OF PREHISTORIC MAN.
Models by Professor J. H. McGregor.

The Hall of the Age of Man in the American Museum

By HENRY FAIRFIELD OSBORN

Third edition, revised and enlarged. Edited by William K. Gregory

The exhibits in the Hall of the Age of Man is intended to illustrate what is known of the origin, relationships and early history of man, as deduced from his remains and primitive implements, and also to show the animals by which he was surrounded in the early stages of his existence. These animals are shown not only as mounted skeletons but in a series of large mural paintings portraying them as they appeared in the flesh amid their natural surroundings. These paintings are the result of the study of their fossil remains and their careful comparison with related existing animals, a work to which the author has devoted many years of study. Hence they give an accurate and vivid idea of the animals that were the contemporaries of early races of man in various regions of the world.

A series of cases in the center of the hall are devoted to the story of man, and that it can be compressed into so small a space is an indication of the scarcity of his remains, for here are displayed reproductions of the most notable specimens that have been discovered. It has been necessary to use copies, for the actual specimens are few in number and scattered through many museums in widely separated parts of the world.

THE beginning of the Age of Man, some 500,000 years ago, roughly estimated as the close of the Age of Mammals, marks in reality but the beginning of the close of the Age of Mammals. The extinction of the most superb mammals that the earth has ever produced, during the early stages of human evolution, progressed from natural

causes due directly or indirectly to the Glacial epoch. With the introduction of firearms the destruction has proceeded with increasing rapidity, and today it is going on, by the use of guns and steel traps, at a more rapid rate than ever. By the middle of this century man will be alone amid the ruins of the mammalian world he has destroyed, the period of the Age of Mammals will have entirely closed, and the Age of Man will have reached a numerical climax, from which some statisticians believe it will probably recede, because we are approaching the point of the over-population of the earth in three of the five great continents.

Man as a Primate

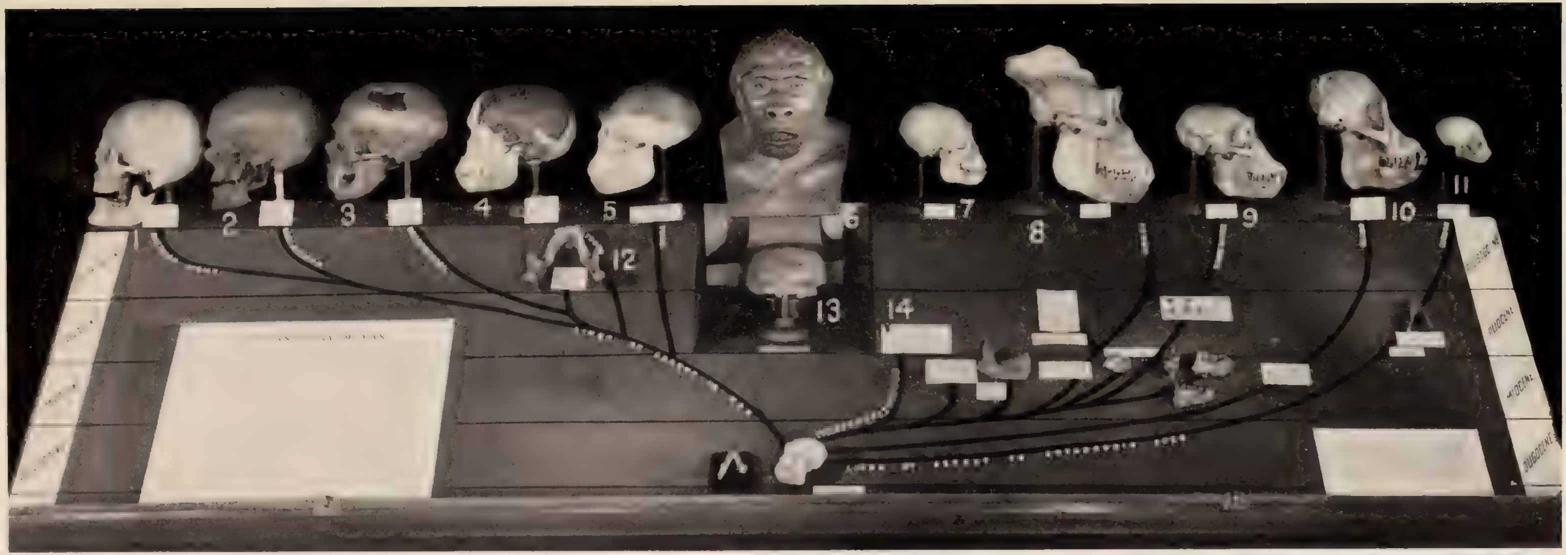
A few of the more striking points of anatomical agreement between men and apes are illustrated in the first A case, which shows comparative series of skulls, lower jaws, and teeth.

In this exhibit skulls of the great man apes (at the right in Case I) are placed for comparison with those of some of the known extinct or fossil races of man, each ascending along a line of its own. Copies of the most recent discoveries in various parts of the world are placed in this series; in fact, this entire exhibit is designed to show from time to time our progress in discovery, to present actual evidence in place of theories and speculations, and to show how very limited this evidence is as compared with the abundant evidence in the ancestry, for example, of the horse (shown in the Hall of the Age of Mammals).

The Ascent of Man

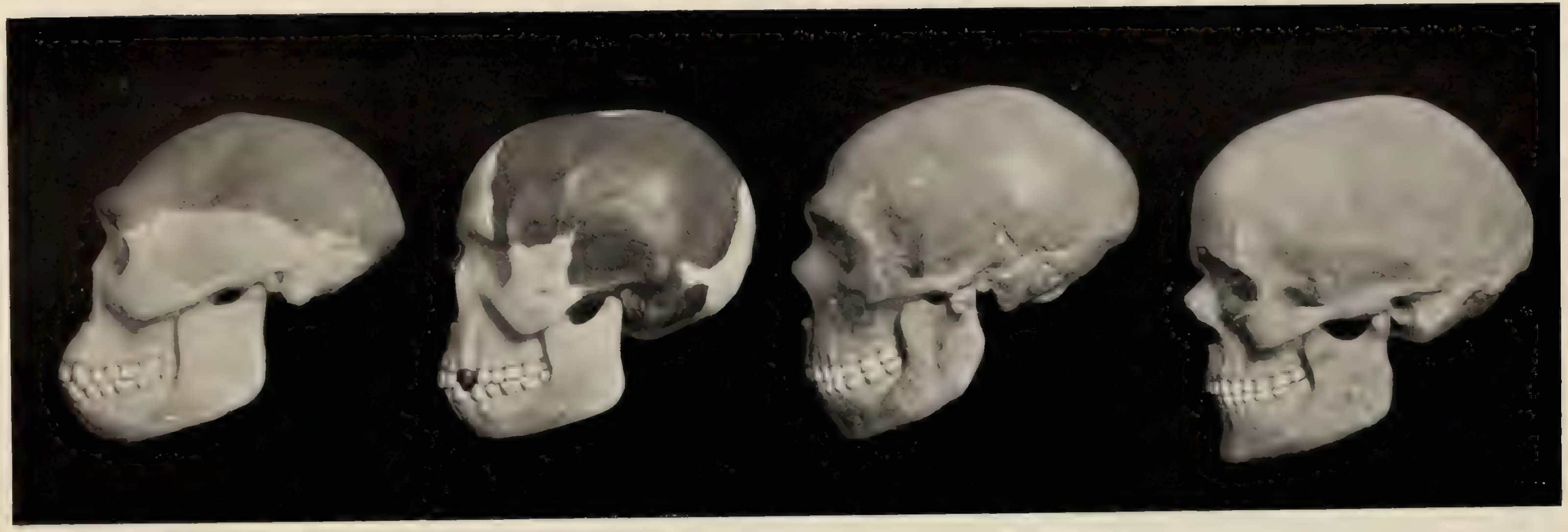
Man has a long line of ancestry of his own, perhaps two million or more years in length. The cradle of the human race was, in our opinion, in Asia, in regions not yet explored by palæontologists. One reason that human and prehuman fossil remains are rare is that the ancestors of man lived partly among the trees and forests; this does not mean that they were arboreal; they lived chiefly on the ground.[1] Even when living in a more open country the ancestors of man were alert to escape the floods and sandstorms which entombed animals like the horse of the open country and of the plains. Hence fossil remains of man as well as of his ancestors are extremely rare until the period of burial began.

[[1]This refers only to the higher, more recent ancestors of man. The most thorough studies of the anatomy of the foot of man and other primates have brought strong support to the view that the human foot has been derived from an earlier ape-like stage in which the great toe could be used in climbing. W. K. G.]



MAN'S PLACE AMONG THE PRIMATES

1. Man (existing human type); 2, old man of Crô-Magnon, cast of original; 3, Neanderthal (Chapelle-aux-Saints), cast of original; 4, Piltdown skull (*Eoanthropus*), reconstructed by Dr. McGregor; 5, *Pithecanthropus*, skull reconstructed by Dr. McGregor; 6. model of bust of *Pithecanthropus*, by Dr. McGregor; 7, young gorilla; 8, adult male gorilla; 9, adult male chimpanzee; 10, adult male orang; 11, *Hylobates*, the larger kind of gibbon; 12, cast of jaw found near Heidelberg. Germany; 13, cast of original skull top of *Pithecanthropus;* 14, type upper molar (cast) of *Hesperopithecus*, a fossil ape from Nebraska The other specimens are casts of various teeth and jaw fragments of fossil apes: *Propliopithecus* (jaw and reconstructed skull) at the bottom, *Sivapithecus* and several species of *Dryopithecus* and allied genera. The geologic ages (Oligocene, Miocene, etc.) are indicated by the horizontal zones. The black lines indicate relationships as inferred by Dr. W. K. Gregory.



SKULL MODELS OF FOUR PREHISTORIC HUMAN TYPES

Reconstructions by Professor J. H. McGregor.

Dark parts represented in the original, light parts restored from other specimens.

1. Trinil Ape-Man (*Pithecanthropus erectus*), Upper Pliocene, Java. Showing a very low type of skull, with strong ape-like characteristics.

2. Piltdown Man (*Eoanthropus dawsoni*), Upper Pliocene (?), Sussex, England. Showing a distinctly higher type of skull; nevertheless, the brain cast is far inferior in the development of its parts to that of modern man. The jaw (of which the right side is preserved in the original) is of very low type, more ape-like than any other known human jaw.

3. Neanderthal Man (*Homo neanderthalensis*), Old Stone Age, Europe. The skull is of very large size but of low type, shallow in height, narrow in the frontal region; face very massive with wide nose and sloping chin.

4. Crô-Magnon Man (*Homo sapiens*), Late Old Stone Age, Centra France. The skull is of high grade, with steep forehead, high vault and vertically straight face.

Fig. 2. Skull fragments found by Dawson and Smith Woodward in 1911, 1912; jaw fragment found by Dawson in 1912; canine tooth found by Father Teilhard de Chardin in 1913; nasal bones found by Dawson in 1913; single worked flint found near original skull fragments by Smith Woodward. Jaw one-third natural size; other fragments a bit larger than one-third (distorted somewhat by camera).

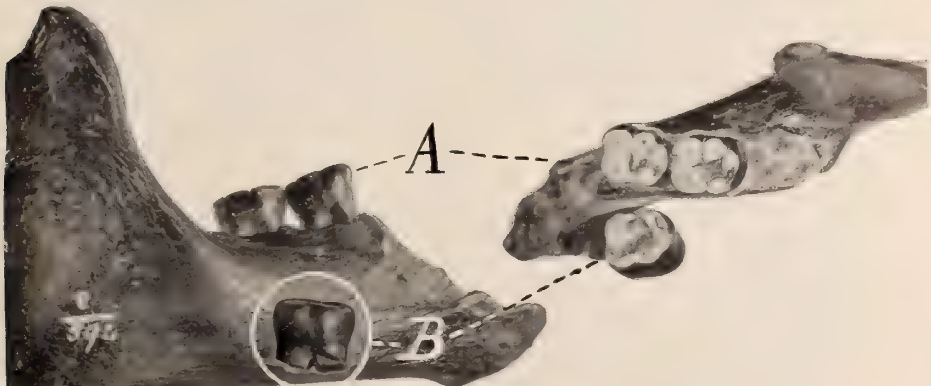


Fig. 3. *A*, side and top views of jaw of first Piltdown man, with first and second lower molar teeth in place. *B*, side and top views of first lower molar tooth of second Piltdown man. About three-fourths natural size.

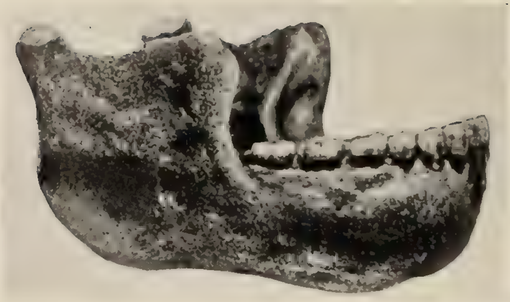


Fig. 4. The "Heidelberg jaw," found at Mauer, near Heidelberg, Germany. About one-third natural size.

Fig. 5. Sand-pit at Mauer, near Heidelberg. X marks the spot where the jaw was found, in place and beneath 79 feet of glacial and post-glacial deposits.

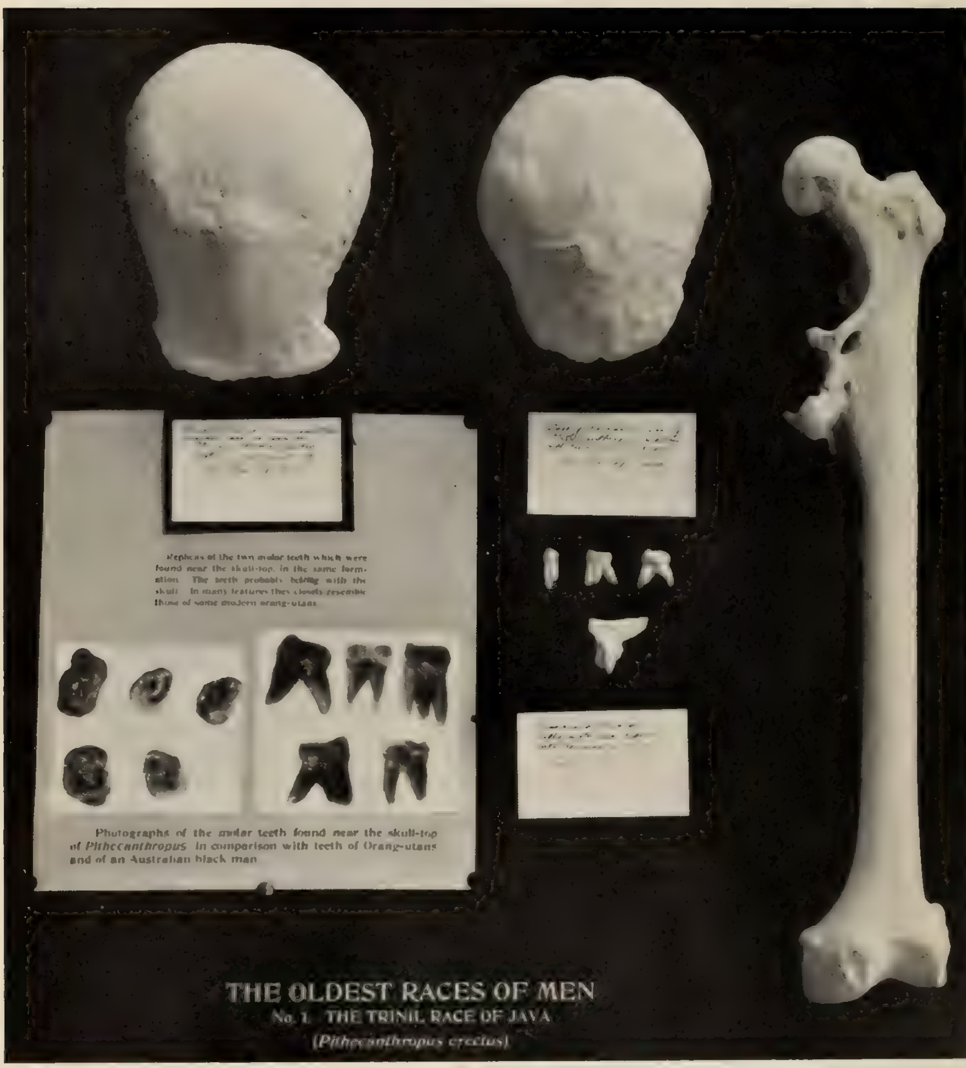
The earliest known human remains of the Trinil, Piltdown and Heidelberg races consist principally of portions of skulls, of jaws, and teeth. Individuals of the prehistoric races of Europe are now represented by casts in the Hall of the Age of Man. The museum series began in 1915 with the gift of the J. Leon Williams Collection, and has been enriched by additions from the museums of London, Paris, and recently by the Neanderthal man of Krapina, presented by Professor K. Gorjanovič-Kramberger, through the kindness of Col. C. W. Furlong; also the Talgai skull from South Australia, presented by Dr. Stewart A. Smith.

The earliest known man is the Foxhall man, known at present only by his flint implements, partly burned with fire, found near the little hamlet of Foxhall, near Norwich, on the east coast of England. These flints, discovered in 1921, constitute the first evidence that man of sufficient intelligence to make a variety of flint implements and to use fire existed in Britain at the close of the *Age of Mammals;* these are the first traces of true Tertiary man ever found.

The Trinil ape-man, the *Pithecanthropus* of Java, is the lowest of the known human or subhuman races. It is called ape-man because it is more human than ape-like. The restored head by Professor J. Howard McGregor, of Columbia University, is designed to show its half human, half anthropoid resemblance, as suggested by the top of the cranium, the only part known, which is far more human than that of any ape cranium, and at the same time far more ape-like than that of any human cranium. It is not impossible that this ape-man is related to the Neanderthal man. The exact geological age of the formation in which the original *Pithecanthropus* remains were discovered has been difficult to settle. The other fossil mammal remains found in the same formation, according to Dubois, Boule and other authorities, were essentially similar to those of the Upper Pliocene age of Europe. On the other hand, according to the geologist Blanckenhorn, the exact relations of the formation to those above and below it indicate a Lower Pleistocene age. In any event the antiquity of the *Pithecanthropus*, in terms of ordinary human experience, is certainly very great, probably not less than 500,000 years.

The Most Ancient Human Races, Piltdown and Heidelberg

A fragmentary skull, the greater part of the right half of the lower jaw, and an isolated tooth, represent the first found remains of the Piltdown man, discovered in England in 1911–12 by Charles Dawson.



PITHECANTHROPUS; THE APE-MAN OF JAVA

Skull top, cast of endo-cranial cavity, femur and teeth (casts). The labels are in the handwriting of Dr. Dubois, the discoverer of this remarkable specimen by whom these casts were presented.

Several reconstructions of the Piltdown skull have been made, the first being that by Professor A. Smith Woodward, now in the British Museum. Another was made in this country, by Professor J. H. McGregor.

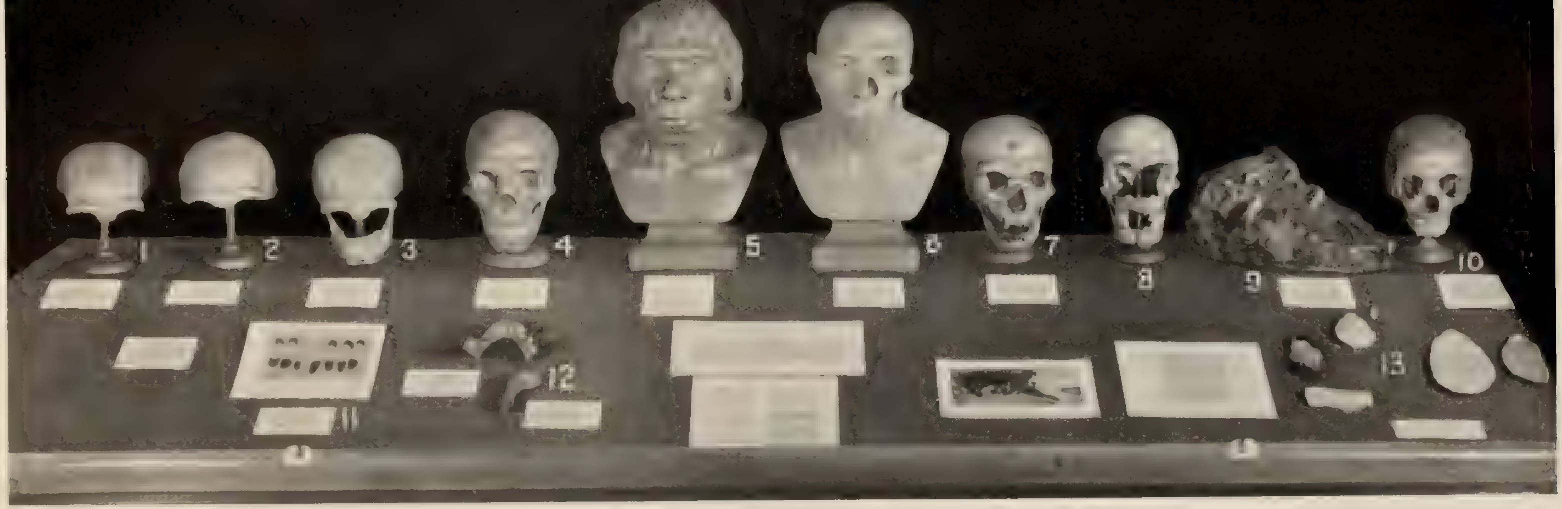
The problem whether the Piltdown jaw belongs to this human skull or whether it belongs to a fossil chimpanzee is now considered settled, because a *second* specimen of the Piltdown man has been found two miles from the first in the same Piltdown gravels; this specimen has the same kind of lower grinding teeth and the same form in the bone of the forehead. The skull itself is of a primitive human type, the brain cast showing a lowly development of the higher cerebral association centers (Elliot Smith, 1922).

In the deposit that contained the Piltdown remains were found some flint implements of Chellean type and two lots of fossil mammal remains, mostly teeth. The first lot were badly waterworn and had probably been washed out of an older deposit and then redeposited. The second lot, like the human bones, were not waterworn, and are believed by many geologists to be of the same age as the human remains. This lot included teeth of beaver, horse, deer and hippopotamus, animals which have been found elsewhere in Europe in association with flint implements of Chellean type. For these reasons Obermaier and other authorities refer the Piltdown remains to an early phase of the Chellean culture stage of the Lower Palæolithic (Lower Old Stone Age). Its age in the geological time scale may be in either the first or the second Interglacial time of the Pleistocene epoch.

Unquestionably the next most ancient human relic which has thus far been discovered is the jaw of the so-called Heidelberg man, a fossil which may be 250,000 years old. It is notable for its great size and for its lack of a protruding bony chin. The Heidelberg man may be ancestral to the Neanderthal man.

The Neanderthal Race

The Neanderthal man represents the oldest fossil human race of which the skeleton is fully known. The remains are very abundant, and the American Museum owns reproductions of many skulls and parts of skulls found during the last half century in Spain, Germany, France, and Hungary. Foremost of these is the skullcap found near Düsseldorf, Germany, in 1856, which constitutes the type of the Neanderthal race itself.



NEANDERTHALOID RACES OF THE LOWER OLD STONE AGE

1. Cast of the skull top of the type specimen, discovered in the Neander Valley, near Dusseldorf, Germany.
2. Cast of skull top from Spy, Belgium.
3. Cast of skull top and jaw from Spy, Belgium.
4. Reconstructed skull from La Chapelle aux Saints, France.
5. Bust, by Dr. J. H. McGregor, based on skull from La Chapelle aux Saints, France.
6. Half head, half skull model, by J. H. McGregor, based on skull from La Chapelle aux Saints, France.
7. Cast of skull found at La Chapelle aux Saints, France.
8. Reconstruction of skull found at La Quina, Charante, France.
9. Cast of La Quina skull and skeletal fragments as found.
10. Cast of skull found at Le Moustier, France.
11. Casts of feeth found at St. Brelade, Isle of Jersey.
12. Casts of lower jaw from Malarnaud, France, and of lower jaw from La Naulette, France.
13. Mousterian Flint Implements.

Painted by Charles R. Knight under the direction of Henry Fairfield Osborn. Copyrighted photograph

THE NEANDERTHAL FLINT WORKERS

Of great interest is the reconstruction by Professor McGregor of a Neanderthal female head, based upon a skull found at Gibraltar in 1848, which gives us the head characters of the women of this very primitive race.

Nearly perfect is the skull from La Chapelle-aux-Saints, originally restored by Professor Marcellin Boule, of Paris, and reconstructed by Professor McGregor; this distinguished American expert in the anatomy of palæolithic man is now engaged upon the reconstruction of the entire skeleton and body of the Neanderthal man. This life-sized Neanderthal model will be one of the most interesting exhibits in the American Museum; it represents many years of laborious study and research by Professor McGregor, who was sent by the Museum on a special tour through Europe to examine all the known fossil remains of the Neanderthal race, representing forty or fifty individuals altogether, including the last specimen to be found, that of La Ferrassie, France, which is now being described by Dr. Boule.

The Rhodesian Race

The most recent discovery is the Rhodesian man, *Homo rhodesiensis*, made in 1921, in a cave at the Broken Hill Mine, northern Rhodesia, Africa, where the human remains were found in association both with stone and bone implements, and with broken bones of animals which had evidently been used as food. This man was in the Stone Age of industry, using scrapers and knives of quartz and quartzite. The forehead is very low and the ridges above the orbit are excessively prominent; the opening for the nose was very wide, but the palate and teeth are like those in existing races. The brain is of a very low human type of the capacity of 1,280 c.c. (see Smith Woodward's *Guide*, pp. 29–31).

The Neanderthal Flint Workers

The mural of the Neanderthal group of flint workers shows in the distance, along the Dordogne River, herds of woolly rhinoceroses. The center of interest is the flint industry, which, with the chase, occupied the entire energy of the Neanderthals. Since the Neanderthal type is totally different from any modern human type, it must be studied from models of its own. The group is very carefully arranged to show the physical characters of this man: the knees slightly bent in the peculiar standing posture, the broad, heavy shoulders, slightly stooped, and the massive neck and the head set well forward. In the background is the famous cavern of Le Moustier, which gives its name to the Mousterian period of flint industry pursued by the Neanderthals.

TYPICAL CRÔ-MAGNON RACES UPPER OLD STONE AGE

1. Combe-Capelle (cast) found near Montferrand, France.
2. Skull (cast) of type specimen, one of five individuals found at Les Eyzies, Dordogne, France.
3. Skull (cast) of type specimen, with teeth and some missing parts restored from study of other skulls of this race.
4. Skull of type specimen, with flesh added on one side, to show the general form of the head.
5. Completed bust, by Dr. J. H. McGregor, modeled on the type skull.
6. Skull top (cast) found with type specimen of Les Eyzies.
7. Skull of female (cast) found at Les Eyzies, France.
8. Photograph of skeletons of the Grimaldi Race, found near Mentone, France.
9. Painted caves, and rock shelters of Men of the Old Stone Age in France.
10. Aurignacian Implements.
11. Grotto du Prince.
12. Photograph of Crô-Magnon skeletons found near Mentone, France.

Painted by Charles R. Knight under the direction of Henry Fairfield Osborn. Copyrighted photograph.

CRÔ-MAGNON ARTISTS PAINTING THE MAMMOTH

The Crô-Magnon Race of High Type

The highly evolved Crô-Magnon race entered Europe from the east and drove out the Neanderthals. The Crô-Magnons were people like ourselves in point of evolution, and the characters of the head and cranium reflect their moral and spiritual potentiality. This was a race of warriors, of hunters, of painters and sculptors far superior to any of their predecessors. The contrast between the Crô-Magnon head and those of the Neanderthals which precede them is as wide as it possibly could be. It is intellectual and thoughtful.

Although these people lived at the very close of the long glacial period, they are far older than the Egyptian and Assyrian civilizations, which we ordinarily think of as being of the utmost antiquity.

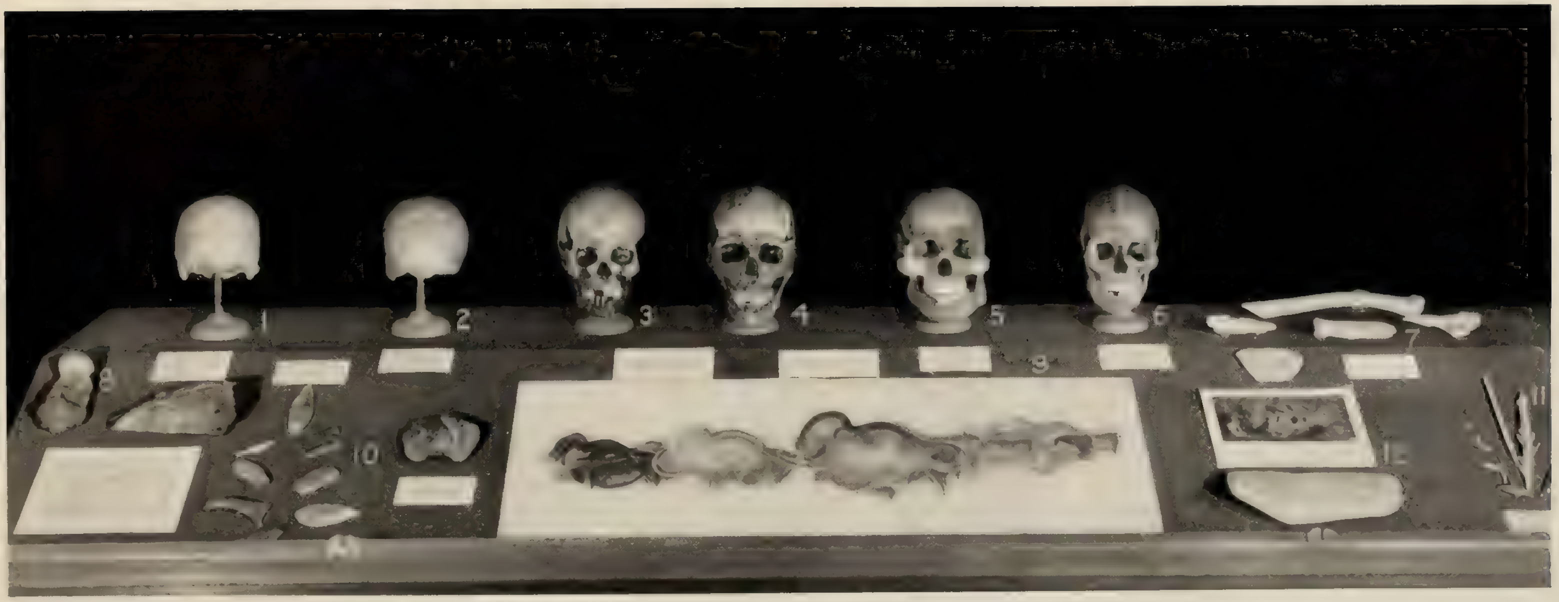
Crô-Magnon Artists Painting the Mammoth

One of the recent murals in the Hall of the Age of Man (over the doorway opposite the Crô-Magnon exhibit) represents four of the Crô-Magnon artists actually painting the great fresco in the cave of Font-de-Gaume, Dordogne, France. The writer has been studying the composition of this group for years, with Mr. Charles R. Knight, artist, aided by advice of the Abbé Henri Breuil of the Institut de Paléontologie Humaine, Paris, as well as of Mr. N. C. Nelson, archæologist at the American Museum of Natural History.

There are six figures in the group; four are depicted partly nude to show their anatomy in contrast with that of the Neanderthals. The two half-kneeling figures are holding up small lamps to illuminate the smooth surface of the limestone wall on which the procession of mammoths is being depicted. The half-erect figure represents an artist with pointed flint incising the outlines of a mammoth on the wall. The fully erect central figure represents an artist laying on the colors. A kneeling figure is preparing the colors on a rock. This design enables the painter to show the tall, slender proportions of the men of this Crô-Magnon race. The standing figure to the left is that of a chieftain clothed in well-made fur garments, who carries on top of his staff his *baton de commandement* as the insignia of his rank. The only illumination is that of the flickering wicks in the small oil lamps.

Contrast Between the Old Stone Age (Palæolithic) and the New Stone Age (Neolithic)

The men of the Old Stone Age lived in Europe during the immensely long periods when the great glacial ice-sheets gradually extended from the mountains out into the open regions, and then as slowly drew back



CRÔ-MAGNON AND ALLIED UPPER OLD STONE AGE RACES

1. Cast of skull found at Langwith cave, Derbyshire, England.
2. Cast of skull found at Brünn, Moravia.
3. 4. Casts of skulls found at Predmost, Czechoslovakia.
5, 6. Casts of skulls of man and woman found at Obercassel, near Bonn, Germany.
7. Solutrean implements.
8. Cast of ivory statuette of mammoth, made by "Predmost mammoth hunters."
9. Crô-Magnon cave drawings.
10, 11. Magdalenian implements.
12. The Mammoth, engraved on a piece of mammoth tusk (cast).

UPPER MAGDALENIAN, AZILIAN, TARDENOISIAN

1, 2. Casts of skulls found in a burial grotto of Furfooz, near Namur, Belgium. Upper Magdalenian.
3–6. Casts of skulls from a grotto at Ofnet, near the Danube, Germany. Azilian.

MEN OF THE NEW STONE AGE (Neolithic)

7–9. Casts of skulls from Sclaigneaux, in the valley of the Meuse, Belgium.
10. Cast of skull found at Galley Hill, England.
11. Broadheaded Alpine type.
12. Neolithic implements.

Fig. 6. The progress of primitive man as shown by his tools and weapons.

A. IMPLEMENTS TYPICAL OF THE EARLY PALEOLITHIC AGE

1. Hand-ax or chopping tool of flint.
2. Dagger or perforating tool of flint.
3. Implement of flint for various purposes, such as cutting and scraping.

B. IMPLEMENTS AND ORNAMENTS TYPICAL OF THE LATE PALEOLITHIC AGE

1. Knife blade or spear point of flint.
2. Knife or etching tool of flint.
3. End scraper or planing tool of flint.
4. Harpoon point of bone.
5. Lance point of bone.
6. Beads or pendants of elk teeth.
7. Beads of univalve shells.
8. Fragment of bone with partial outline of a horse etched upon it.
9. Fragment of bone with traces of geometric ornamentation.

Fig. 7. The progress of primitive man as shown by his tools and weapons (continued).

IMPLEMENTS TYPICAL OF THE NEOLITHIC AGE

1. Ax-hammer of stone, perforated for hafting.
2. Ax of flint, partly polished.
3. Saw of flint, one edge notched.
4. Dagger of flint, probably in imitation of metallic form.
5. Knife or sickle blade of flint.
6. Arrow point of flint, also made in larger sizes and used as spear points.

STONE CULTURES		HUMAN RACES	CONTEMPORARY MAMMALS
HISTORICAL		PERIOD	EXISTING MAMMALS
NEOLITHIC		PERIOD	MASTODON(?)MAMMOTH
AZILIAN MAGDALENIAN SOLUTRIAN	PALEOLITHIC	GRENELLE CRÔ-MAGNON	
AURIGNACIAN		GRIMALDI	
COLD MOUSTERIAN		NEANDERTHAL	REINDEER MAMMOTH WOOLLY RHINOCEROS
WARM MOUSTERIAN			ELEPHAS ANTIQUUS HIPPOPOTAMUS
COLD ACHEULEAN			
WARM ACHEULEAN		KRAPINA	
LATE CHELLEAN		EHRINGSDORF	
CHELLEAN			ELEPHAS ANTIQUUS HIPPOPOTAMUS
EARLY CHELLEAN			
		HEIDELBERG	ELEPHAS ANTIQUUS RHINOCEROS ETRUSCUS HIPPOPOTAMUS SABRE-TOOTH
CROMERIAN		PILTDOWN ?	ELEPHAS PRIMIGENIUS MUSKOX REINDEER
FOXHALLIAN			

Fig. 8. Sequence of Old Stone Age (Paleolithic) in Europe.

The order in which the races of primitive men appeared in Europe and the most striking mammals living at the same time.

COLORED PEBBLES FROM MAS D'AZIL. FRANCE
(From Obermaier's *Fossil Man in Spain*)

before the increasing heat of the summer seasons. The woolly mammoth, the woolly rhinoceros, the wild horse, and later the reindeer, were abundant, and were hunted by the skilled makers of chipped flint implements. The men of the New Stone Age, on the other hand, came into Europe after the greatest severity of the glacial climate had passed, and were surrounded mostly by forms of animals still existing. While not possessing the wonderful artistic ability of their predecessors, the Crô-Magnon cave artists, the men of the New Stone Age made pottery and cloth, and erected great sepulchres and temples of stone for their dead. They lived in more or less settled communities and depended upon an artificial food supply, raising cereals and keeping flocks and herds, instead of depending wholly upon hunting. Thus they were the true forerunners of civilization. Their skulls and skeletons also show that they belong to races still existing, including the Alpines or Central Europeans and the Mediterraneans or South Europeans.

The Azilian or Transitional Period Between the Old Stone Age and the the New Stone Age

The people that colored the pebbles pictured on page 25 lived in the transitional period, called Azilian, between the Old Stone Age and the New Stone Age. Like the men of the Reindeer Age (Magdalenian, or close of the Old Stone Age) they made small chipped flint implements for planers and knives, and awls and polishers from bone; but their flint implements were very small and angulate. Because of the increasing scarcity or absence of the reindeer, which had been abundant in the dry, cold climate of Magdalenian times, the Azilians were forced to fashion their harpoons out of stag antlers. Unlike their predecessors they did not make the beautiful engravings and sculptures of animals on bone or draw realistic animal pictures on the walls of caves.

On the other hand they differed from their successors of the New Stone Age in that they had no pottery or domesticated animals.

Colored Pebbles from Mas D'Azil, France

(From Obermaier's *Fossil Man in Spain*, 1924)

These colored pebbles were found in the great cavern of Mas d'Azil, in the foothills of the Pyrenees, about forty miles southwest from Toulouse, France. The cavern had been frequented by men of many successive ages, who left no less than nine layers of deposits ranging from the Early Magdalenian (late Old Stone Age) through the Neolithic (New

Stone Age) to the Iron Age of the Gauls and Romans. The pebbles were found in the sixth layer, above the late Magdalenian layer, and just below the Neolithic level. Thus the people that used the colored pebbles lived in the transitional period (Azilian) between the Palæolithic and the Neolithic. The pebbles are painted on one side with peroxide of iron, a deposit of which is found in the neighborhood of the cave. The symbols, in some cases at least, are conventionalized designs from earlier and more realistic representations of objects. Their use is not fully known—perhaps they might have been pieces in a game, or "luck stones."

Men of the New Stone Age

Men of the Neolithic, or New Stone Age, continued to use chipped stone implements, but unlike their predecessors, they often polished them. They were the direct forerunners of civilization. They cultivated the ground, raising cereals, and had domesticated cattle and other animals; they made pottery and wove textiles; they lived in villages of huts, often built on piles near the shores of lakes. They erected sepulchres and temples of huge stones (dolmens, megaliths)

The Neolithic Stag Hunters

This mural group also is in its place in the hall (at the west end) having been completed in 1919. It represents men of the Nordic race, brown- or fair-haired, hunters of the stag, living along the southern shores of the Baltic in the earliest stage of the New Stone Age, a stage known as the Campignian from remains of huts and rudely polished stone implements found near Campigny in France. The scene is on the border of one of the northern beech forests and represents the return from the hunt. After the ardor of the chase the hunters have thrown off their fur garments. The chieftain in the center is partly clad in furs; in the coming winter season he will be wholly fur clad. His son, a fair-haired youth with a necklace of bear claws, grasps a bow and arrow and holds in leash a wolf dog, ancestor of the modern sheep dog of northern France. The hunters, with spears tipped with stone heads, are resting from the chase. Two vessels of pottery indicate the introduction of the new ceramic art, accompanied by crude ornamentation.

This race was courageous, warlike, hardy, but of a lower intelligence and artistic order than the Crô-Magnons: it was chiefly concerned, in a rigorous northern climate, with the struggle for existence, in which the qualities of endurance, tribal loyalty, and the rudiments of family life

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted Photograph

STAG HUNTERS OF THE NEW STONE AGE (Neolithic)

Men of the Nordic race, brown- or fair-haired, living along the southern shores of the Baltic in the earliest stage of the New Stone Age.

were being cultivated. Rude huts take the place of caverns and shelters, which are now mostly abandoned.

These were tall men with high, narrow skulls, related to the existing Nordic race, more powerful in build than the people of the Swiss Lake Dwellings. Skulls and skeletons representative of this hardy northern type are abundantly known in Scandinavia, but have not as yet found their way to our American Museum collections.

The Great Fossil Mammals Contemporaneous with and Hunted by Man

The Hall of the Age of Man contains four chief collections of the mammals of the world during the period of the Age of Man. In Europe man hunted the reindeer, the wild horses and cattle, and the mammoth. He used the hide of the reindeer for clothing, the flesh and marrow for food. He carved the bones as well as the ivory tusks of the mammoth.

The successive cultural stages appear to have originated first in Egypt and southwestern Asia, whence they spread into southeastern Europe, finally reaching northwestern Europe.

The mammoth, the northern, hairy type of elephant known to early explorers of fossil remains, was foremost among the great mammals hunted by man. The previous history of the proboscidean order is also shown in the Hall of the Age of Man.

This is one of the romances of evolution quite equal in interest to the evolution of the horse and the collection in the museum is remarkably complete. The early stages in the evolution of the proboscideans, beginning with the *Palæomastodon* discovered in the Fayûm region of northern Africa, carry us back into times far antecedent to the Age of Man, namely, into an early period of the Age of Mammals, the Oligocene. Thus the visitor can see here the entire history of the evolution of the proboscideans, which taken altogether is the most majestic line of evolution that has thus far been discovered. The evolution of the proboscideans culminates in the mastodons and mammoths.

Four Scenes in the Glacial Epoch

The four great murals on the north wall of the Hall of the Age of Man represent scenes near the close of the Glacial epoch in the Northern Hemisphere.

These four scenes belong in the same period of geologic time, namely, the final glacial stage, the period of the maximum advance of the glaciers over the entire Northern Hemisphere, of the most intense

cold, and of the farthest southward extension of the northern types of mammals. This is the time of the Crô-Magnon race, and our knowledge of the mammals, reindeer, and rhinoceroses is derived from the actual Crô-Magnon paintings and etchings, chiefly those found within the caverns. The murals are as follows:

Midwinter.—The woolly rhinoceros in northern France.

Early Winter.—The reindeer and mammoth on the river Somme, France.

Midsummer.—The mastodon, royal bison, and horse on the Missouri River, in the latitude of Kansas.

Autumn.—The deer-moose, tapir, and giant beaver, in northern New Jersey.

Glacial Midwinter in Northern France

The woolly rhinoceros, like the woolly mammoth, was heavily enwrapped in hair, beneath which was a thick coat of fine wool. With this protection the animal was quite indifferent to the wintry blasts which swept over the steppe-like country of northern France. This golden-brown wool is actually preserved on the side of the face of one specimen discovered, which is now in the Museum of Petrograd (Leningrad). The head of the rhinoceros was long and narrow, like that of the white rhinoceros of Africa, but the jaws were narrower and the upper lips were more pointed. It is an animal quite distinct from the great white rhinoceros still extant in Africa, which is a grazer with broad lips. In the distance in the painting are shown the saigas, antelopes which wandered over France at that time, and a group of woolly mammoths.

Early Winter Scene on the Somme River in Northern France

The scene represents the two herds, reindeer and mammoth, migrating southward from the banks of the river Somme. These reindeer and mammoths are, in fact, depicted very precisely in the paintings and engravings left by the Crô-Magnon artists—especially in the cavern of Font-de-Gaume. It is a striking fact that, in the case of the mammoth, every painting, drawing, etching, and model which the Crô-Magnon man has given us exhibits exactly the same characters: the long hairy covering, the very high hump above the forehead, the notch between the hump and the neck, the very high shoulders, the short back, the rapid slope of the back over the hind quarters, the short tail. There is no doubt that, aided by these wonderful Palæolithic designs, the artist, Mr. Knight, has given us a very close representation of the actual appearance of the woolly mammoth.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

THE WOOLLY RHINOCEROS IN A GLACIAL WINTER, NORTHERN FRANCE

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

THE REINDEER AND MAMMOTH ON THE RIVER SOMME, FRANCE

These animals were abundant in Europe in the cold dry climate, south of the great slowly retreating ice-sheet of the "Fourth Glaciation." They were hunted and accurately depicted by the Crô-Magnon artists.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

THE MASTODON, ROYAL BISON AND HORSE ON THE MISSOURI RIVER, IN LATE GLACIAL TIMES

South of the farthest advance of the ice sheet the mastodon lived in the forests of the east, while giant bisons and wild horses roamed on the plains of the west. Many occurrences of fossil human bones have been reported in North America, but none have yet been proven to be older than the latest glacial times.

Midsummer on the Missouri

The summer scene on the Missouri River (on the parallel of Kansas) represents the region south of the farthest advance of the ice sheet. The mastodons are grouped in such a manner as to show the characteristic low, flattened head, the long low back, the symmetrical fore and hind quarters, the extremely short, massive limbs, and the very broad and massive hip region as seen from behind. In the center of the picture stands the majestic *Bison regius*, the royal bison, known only from a skull, a superb specimen with the horn cores attached, in the collection of the American Museum. These animals were like gigantic buffalo or bison, beside which the modern buffalo would appear very diminutive. The characters of the hair and wool are not known, but it is assumed that they were similar to those of the existing buffalo, since the paintings of the bison by the Crô-Magnon artists in France all show the distinctive beard below the chin. At the right is a group of wild American horses of the period, the last of their race in this country; the species is *Equus scotti*, the skeleton of which has been discovered in northern Texas.

Early Autumn in New Jersey

The autumn scene in northern New Jersey embraces three very distinctive North American types of the period, all of which have become extinct. The deer-moose, *Cervalces* (to the left), was described by Professor W. B. Scott, of Princeton, from a single skeleton found in the marl beds of northern New Jersey, which is now preserved complete in the Princeton Museum. The American fossil tapir (in the center) is known from sparse remains, the best of which were among the earliest discoveries of the pioneers of American palæontology. The giant rodents of the genus *Castoroides* (see two individuals at the right in the painting) are known from nearly complete skulls and skeletons discovered in New York, Ohio and other central western states.

The Tar Pools of Southern California

This mural represents a scene in southern California, in the vicinity of the Rancho-la-Brea deposits, including the remains of the astonishing group of animals caught in the asphalt trap, so splendidly represented in the collection of the Museum of History, Science, and Art, of Los Angeles.

The most characteristic animals of North and South America that lived during the Age of Man (see the south side of the hall) are known through some of the unique remains from the famous deposits of Rancho-

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

THE MASTODON

This distant relative of the elephants may have been a contemporary of early man in the closing phases of the period of the glaciers, in North America. The average mastodon was under nine feet in height, but he was very heavily built, being nearly twice as broad as an elephant.

Painted by Charles R. Knight, under the direction Henry Fairfield Osborn. Copyrighted photograph

THE WOOLLY MAMMOTH

This great elephant was characteristic of the latter part of the period of the glaciers in Europe He wa hunted by the Crô-Magnons. Owing to differences in scale of the figures the Mammoth is made to appea much larger than the Mastodon which was not the case. The Mammoth was a few inches the taller, about th size of the Indian Elephant, but the Mastodon was much the bulkier. and very much the heavier of the two.

la-Brea of southern California, especially the sloths, saber-toothed tigers, and wolves of the period—to which it is hoped that we may add some of the less abundant forms, like the camel and the horse. So far as possible, through exploration and exchange, this quarter section of the hall will represent the mammalian life of North America, in contrast with the mammalian life of South America during the same period of time.

A Loess Storm on the Pampas of Argentina

A mural on the western wall (at the left) of the Hall of the Age of Man presents a South American scene during the Old Stone Age. It depicts the ancient pampas of Argentina with the winding river La Plata in the background, and a typical extinct mammalian fauna. In the distance at the right a violent dust storm is transporting columns of fine, impalpable dust known as loess.

The Museum is extraordinarily rich in the great Pampean Collection presented by certain of the trustees in 1899. This collection shows the close connections between North and South America in glacial times.

One of the most wonderful groups of fossils in the Museum, is the sloth and glyptodont group on the southern side of the Hall of the Age of Man): this includes five great sloths of three species (the *Mylodon, Lestodon* and *Scelidotherium*) and three glyptodonts. These animals, so entirely different in external appearance and habits, nevertheless belong to the same order of mammals, the Edentata, which is distinguished by the absence of enamel on the teeth. It is important to bring these two animals together in the same exhibit, so as to show the very wide contrasts in adaptation which may occur within the limits of a single mammalian order: the sloths covered with long hair and with vestiges of armature embedded in the skin, the glyptodonts nearly hairless, and encased in powerful bony armature, which may have protected them from attack by the saber-toothed tiger of the period.

Appendix

The Family Tree of Man

By William K. Gregory

Man is no doubt vastly superior to his distant relatives the anthropoid (man-like) apes. His brain and mind are on far higher levels of development, he walks erect, he is able to speak. Man has a long line of ancestry of his own, extending for perhaps two million years or more, far back into the Age of Mammals.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

AUTUMN IN NORTHERN NEW JERSEY DURING LATE GLACIAL TIMES

The deer-moose (*Cervalces*) was a species of deer (now extinct) combining characters of the deer and of the moose; the tapirs (center), are related to those now found in Central and South America; the giant beaver (right) is now extinct.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph

THE DEATH-TRAP OF RANCHO LA BREA, CALIFORNIA

Animals gathered around a "tar-pool" or asphalt pit. Giant condors, sabre-tooth tigers and ground sloths (*Mylodons*) in the foreground; wolves and mammoths in the background. Attracted by the water on the surface, one of the sloths is becoming mired in the treacherous pit. The scene represents the abundant animal life of Southern California during the latter part of the glacial times, when the eastern states and northern Europe were covered by great ice sheets.

Painted by Charles R. Knight, under the direction of Henry Fairfield Osborn. Copyrighted photograph.

A LOESS STORM ON THE PAMPAS OF ARGENTINA

The glaciers which covered so much of the northern hemisphere with a vast ice sheet during the Age of Man, were only locally developed in South America and never invaded the pampas of Argentina. Here lived a great assemblage of strange mammals, whose remains were often buried by the storms of fine dust (loess). The scene depicts in the foreground two giant ground sloths (*Mylodon, Lestodon*) and three glyptodonts; at the left a couple of toxodons are quietly browsing, while at the right are some of the slender-limbed Macrauchenias.

THE ASCENT OF MAN FROM LOWER MAMMALS
Showing the main and side branches of his family tree

KEY TO STAGES

1. Primitive Primate (*Notharctus osborni*). Fossil skull and jaw, slightly reconstructed, of Eocene age, Wyoming, U. S. A. Original in American Museum of Natural History, New York.

2. Prototypal anthropoid. Reconstruction, based on fossil jaw (*Propliopithecus hæckeli*) of Oligocene age, Egypt. Original jaw in Stüttgart Museum, Germany.

3.

4. Primitive anthropoid. Reconstruction, based on fossil jaws (*Dryopithecus frickæ*), of Miocene age, India. Original jaws in American Museum of Natural History, New York.

5. Trinil Ape Man. Reconstruction, based on fossil skull-top (*Pithecanthropus erectus*) of Upper Pliocene or Lower Pliocene age, Java. Original in Teyler Museum, Haarlem, Holland.

6. Piltdown Man. Reconstruction, based on fossil skull and lower jaw (*Eoanthropus dawsoni*) of Pleistocene age, England. Original in British Museum (Natural History) London.

7. Heidelberg Man. Reconstruction, based on fossil jaw (*Homo heidelbergensis*) of Lower Pleistocene age, Germany. Original in University of Heidelberg, Germany.

8. Neanderthal Man. Fossil skull and jaw, slightly restored, of the Old Stone Age, Europe. Originals in Paris Museum of Natural History.

9. Crô-Magnon Man. Fossil skull and jaw, slightly restored, of late Palæolithic age, France. Originals in Paris Museum.

10. American. Representing the Caucasian group.
11. Chinese. Representing the Mongolian group.
12. Hottentot. Representing the Negro group of races.
13. Australian black-fellow. One of the most primitive of existing human races.
14. Gorilla, Africa.
15. Chimpanzee, Africa.
16. Orang-utan, Borneo.
17. Gibbon, India.

Brain Casts of: 1, Gibbon; 2, Chimpanzee; 3, Gorilla; 4, Pithecanthropus; 5, Neanderthal Man; 6, Modern Man.

Skull Sections of: 7, Chimpanzee; 8, Pithecanthropus; 9, Neanderthal Man; 10, Crô-Magnon Man.

Lower Jaws of: 11, Chimpanzee; 12, Piltdown Man; 13, Ehringdorf Man (Neanderthaloid); 14, Heidelberg Man; 15, Neanderthal Man; 16, Crô-Magnon Man; 17, Modern Man.

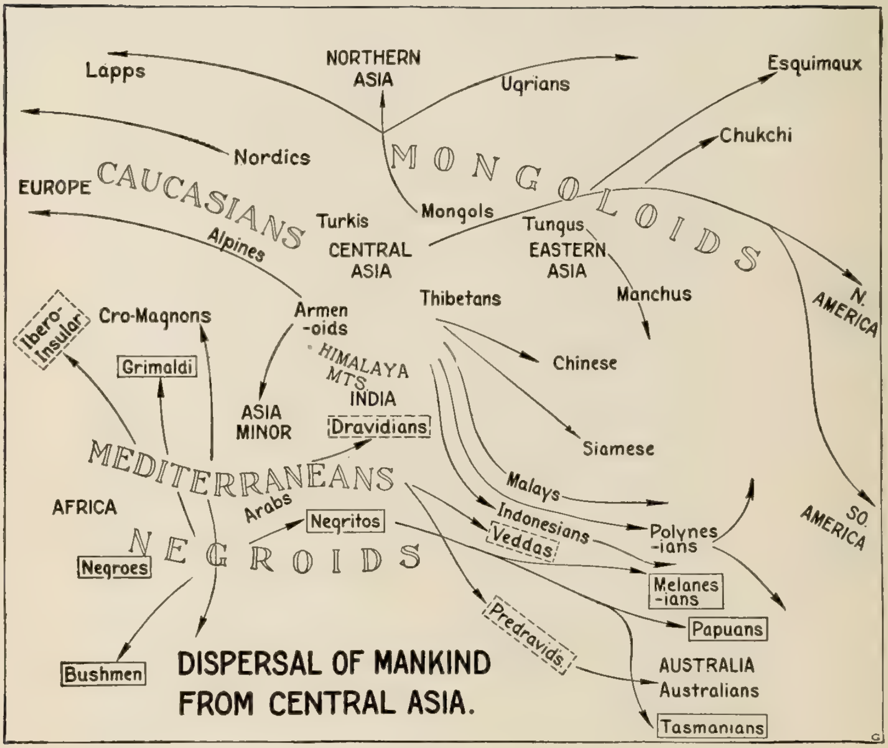
COMPARATIVE ANATOMY OF MAN AND ANTHROPOIDS

The striking resemblance in anatomical plan between man and his nearest known relatives, the anthropoid apes, is well illustrated in these comparative series of "brain-casts," skull-sections, and lower jaws.

The "brain-casts" at the top are casts of the brain-containing cavity of the skull and represent the general form of the brain, as covered by its membranes and blood-vessels. Commencing at the left, with the brain-cast of the gibbon (the most primitive of existing anthropoids, or great apes), the series shows a progressive increase in size and complexity as we pass to the chimpanzee, gorilla, and *Pithecanthropus* (the most primitive known representative of the human family). The brain of the Neanderthal race, while larger in bulk than most modern human brains, was inferior to them in many respects. It was relatively low in proportion to its width, and its frontal lobes, the seat of some of the higher mental faculties, are narrower and less developed than in modern man.

The series of skull sections indicates the following changes as we pass from the anthropoids toward man: (1) the increasing size and depth of the brain; (2) the progressive elevation of the forehead; (3) the forward growth of the brain-cavity above the face; (4) the reduction in size of the bony face, and (5) the retraction, or shrinking backward, of the front part of the jaws.

The lower jaw series shows the inner side of the right half of the jaw, beginning with that of the chimpanzee. In this stage the front end of the jaw slopes backward, while in modern white man it slopes forward. Intermediate stages are seen in the Piltdown, Ehringsdorf, Heidelberg, Neanderthal and Crô-Magnon jaws, all belonging to races now extinct. This progressive development of the chin has probably been partly associated with the increased use of the tongue as an organ of speech.



DISPERSAL OF MANKIND FROM CENTRAL ASIA.

Since remains approximately a half million years old, identified as those of man, have been found in England, in Germany and in Java, it is apparent that early man was a great traveler. Did an ancestral race live in central Asia? Mongolia and Tibet are a favorable geographic region for the beginning of man, who is usually held to have originated in one place and branched widely.

Yet the science of comparative anatomy has revealed the fact that man is constructed upon the same general anatomical plan as that of his more backward relatives, the gorilla and the chimpanzee, and that he is connected with them by a very large number of anatomical marks of distant kinship. The common plan, with differences in detail, upon which man and the great apes are constructed, becomes more and more evident and indisputable as our practical knowledge and experience of human and comparative anatomy increase.

The science of comparative anatomy, in combination with the science of palæontology, has provided the basis for the exhibit called "The Family Tree of Man," which is an attempt to present in a simple graphic form what is accepted by the best scientific authorities.

The Primates first became distinguishable from other orders of mammals very early in the Age of Mammals, that is, some three million years ago, according to the most conservative estimate. The first Primates were even at that early time adapted for living in trees and had grasping hind feet, but as may be judged from their small crania, they were greatly inferior in brain development to their modern descendants. This stage of evolution is represented in the exhibit by a cast of the skull of an extinct primate, *Notharctus osborni*, from the Middle Eocene of northwestern Wyoming.

The next two stages of ascent are so far known only from two small lower jaws dating from the Lower Oligocene of Egypt. In the first of these, *Parapithecus*, the lower jaw and dentition are intermediate in character between the Eocene tarsioid primates and the oldest anthropoid. In the second jaw (*Propliopithecus*) the number and position of the teeth and the form and detailed arrangement of the cusps of all the teeth are exactly such as would be expected in the common starting point for the divergent lines leading to the gibbons, to the higher apes and to man.

In the long ages of the Miocene epoch (which is at the beginning of the second half of the Age of Mammals) there was a great branching out into different lines on the part of the primitive anthropoid stock, some of which began to foreshadow the modern gorillas and chimpanzees, while others (e.g., *Sivapithecus*) showed certain pre-human characters in the jaw and molar teeth.

By the latter part of the Age of Mammals the pre-human stock had probably become broken up into several distinct species, some of which were more backward, others more progressive toward higher types. The most backward of these early pre-human races was the *Pithecanthropus* or Ape-man, from the Upper Pliocene (late Age of Mammals) or

Lower Pleistocene (early Age of Man) of Java. The top of his skull is strongly reminiscent of the apes and indeed it was long debated whether *Pithecanthropus* was a progressive ape, or a primitive man; but the imprint of the frontal lobes of the brain on the inside of the skull show that he was an extremely primitive man, perhaps ancestral to the Heidelberg and Neanderthal races.

More ape-like than *Pithecanthropus* but a step above the gorilla is the skull of the man-ape found towards the end of 1924, at Taungs, Bechuanaland, Africa and named by its describer, Prof. Raymond A. Dart, *Australopithecus africanus*.

According to Professor G. Elliot Smith "if the progress in the direction of the human family is only slight, it is very important because it is not partial, but affects so many details of the face and skull, and it involves the brain, which obviously is the real criterion of any advance towards the intellectual supremacy of the human family."

The Dawn Man (*Eoanthropus*) of the Upper Pliocene, or Lower Pleistocene of England, had a more progressive type of brain case than that of *Pithecanthropus*, but his lower jaw was very ape-like, lacking a bony chin.

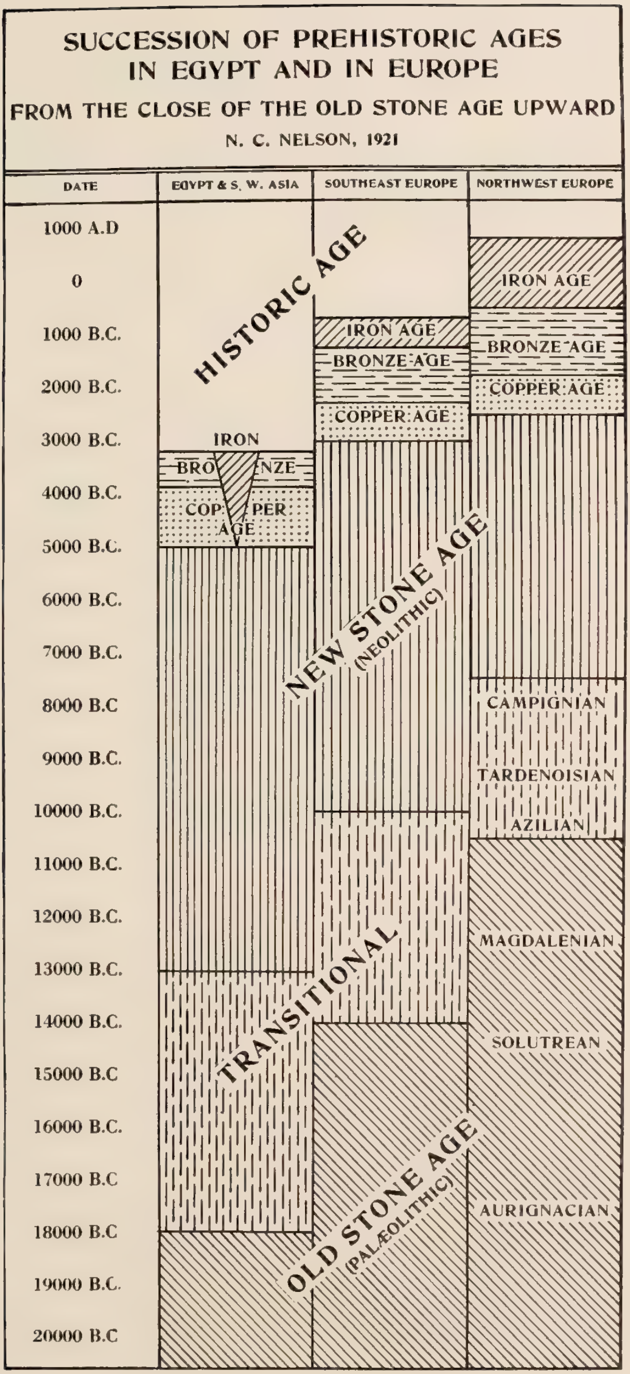
The Heidelberg jaw (Lower Pleistocene age, Germany), although already definitely human, is probably several hundred thousand years old. The jaw is of great size, with retreating chin and primitive human teeth.

The Neanderthal Race occupied Europe in the latter part of the Glacial period. The head is large, but the forehead is low, with strongly projecting brow ridges.

The Crô-Magnon race occupied Europe in the closing stages of Glacial times. It was in a high stage of evolution and belongs with modern races of man in the species *Homo sapiens*.

The Australian aboriginals represent one of the most primitive of the surviving races of man. They are probably distantly related to the most primitive peoples of India and to the early stock of the white races.

The detailed relationships of the other races of men are illustrated in special exhibits in the Introduction to Anthropology, now on the second floor, extreme west tower.


SUCCESSION OF PREHISTORIC AGES
IN EGYPT AND IN EUROPE
FROM THE CLOSE OF THE OLD STONE AGE UPWARD
N. C. NELSON, 1921
DATE
EGYPT & S. W. ASIA
SOUTHEAST EUROPE
NORTHWEST EUROPE
1000 A.D
0
1000 B.C.
2000 B.C.
3000 B.C.
4000 B.C.
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19000 B.C.
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HISTORIC AGE
IRON
BRO NZE
COP PER AGE
IRON AGE
BRONZE AGE
COPPER AGE
IRON AGE
BRONZE AGE
COPPER AGE
NEW STONE AGE
(NEOLITHIC)
CAMPIGNIAN
TARDENOISIAN
AZILIAN
TRANSITIONAL
MAGDALENIAN
SOLUTREAN
OLD STONE AGE
(PALÆOLITHIC)
AURIGNACIAN

The Taungs Man-Ape
Australopithecus

The most recent discovery of a link in the chain of human descent was made at Taungs, Bechuanaland, Africa, and is the fossil skull of a young ape, which shows greater resemblance to man than does that of any other ape.

Dr. G. Elliot Smith, from whom we quote,[1] notes that this statement "must be qualified by the explanation that the step in advance had not carried far beyond the status of the Gorilla. But if the progress in the direction of the human family is only slight, it is very important because (a) it is not partial, but affects so many details of the face and skull, and (b) it involves the brain, which obviously is the real criterion of any advance towards the intellectual supremacy of the human family. This infant ape had a brain almost as big as the largest adult gorilla's, so that in the adult *Australopithecus* it may have attained to a size of 650 or even 700 c.c. If this is only about half the average dimensions of the modern European brain, it is within 250 c.c. of the earliest and most primitive human brain so far discovered—that of *Pithecanthropus*, the capacity of which was about 900 c.c., or at most 950."

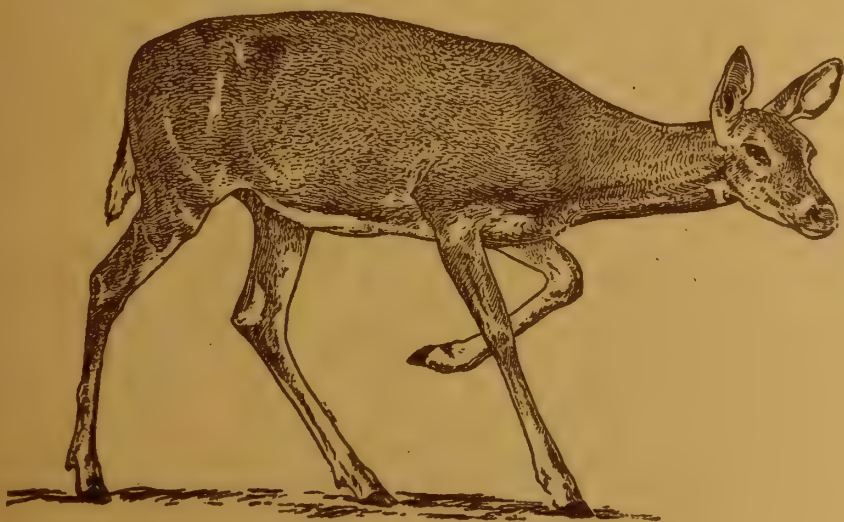
Dr. Smith places *Australopithecus* just below *Pithecanthropus*, and possibly *Hesperopithecus*, in the Family Tree of Man, the one being a Manlike Ape and the other an Apelike Man.

At this time, May 1, no casts of this specimen have reached the United States.

[1] *Australopithecus*, the Manlike Ape from Bechuanaland. "Illustrated London News"—Feb. 14, 1925, p. 240.

AMERICAN MUSEUM OF NATURAL HISTORY

THE STORY OF MUSEUM GROUPS



By FREDERIC A. LUCAS

GUIDE LEAFLET SERIES, No. 53 NOVEMBER, 1921

AMERICAN·MUSEUM PRESS

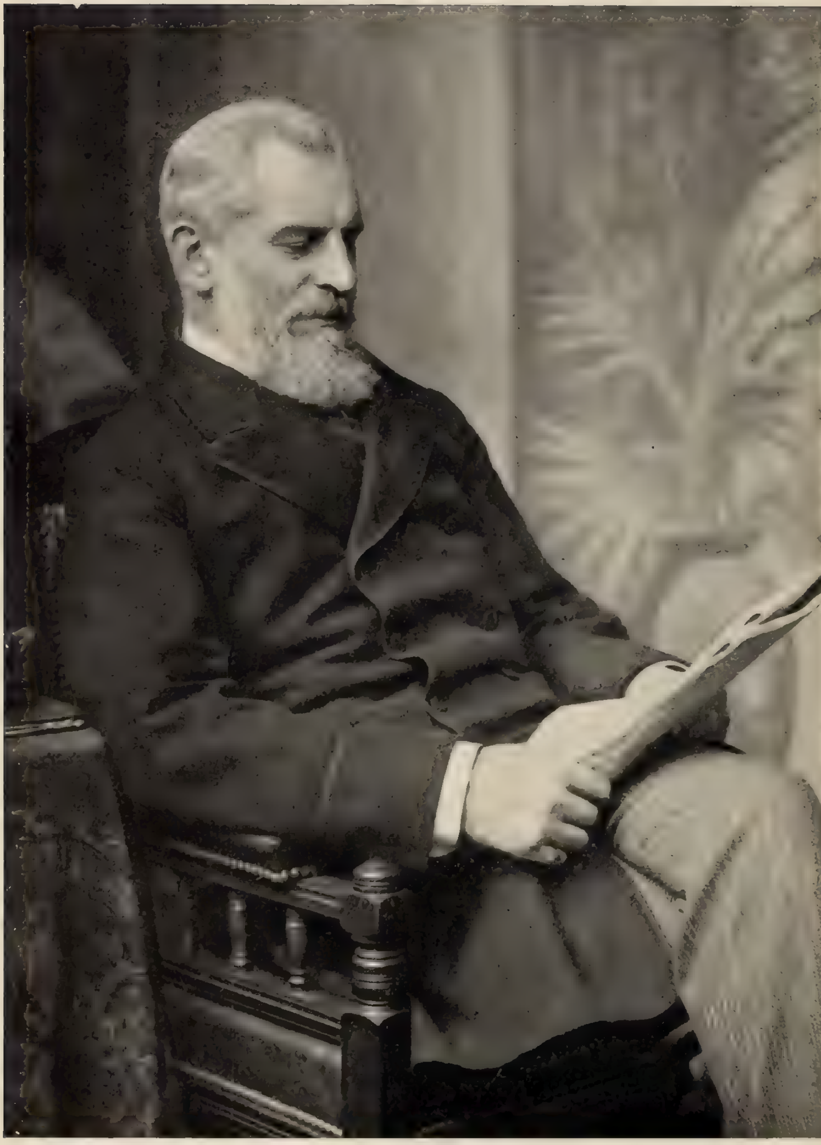
GROUP OF GOLDEN EAGLES

Booth Museum, Brighton, England. Mounted in 1877

object in mounting animals, especially mammals, was to preserve them and put them in a condition to be studied and compared one with another. Groups were not even thought of and, as Dr. Coues wrote as late as 1874: "'Spread eagle' styles of mounting, artificial rocks and flowers, etc., are entirely out of place in a collection of any scientific pretensions, or designed for popular instruction. Besides, they take up too much room. Artistic grouping of an extensive collection is usually out of the question; and when this is unattainable, halfway efforts in that direction should be abandoned in favor of severe simplicity. Birds look best on the whole in uniform rows, assorted according to size, as far as a natural classification allows." The only use of groups was for a few

R. BOWDLER SHARPE

Under whose auspices the first of the bird groups was installed in the British Museum



SIR WILLIAM HENRY FLOWER

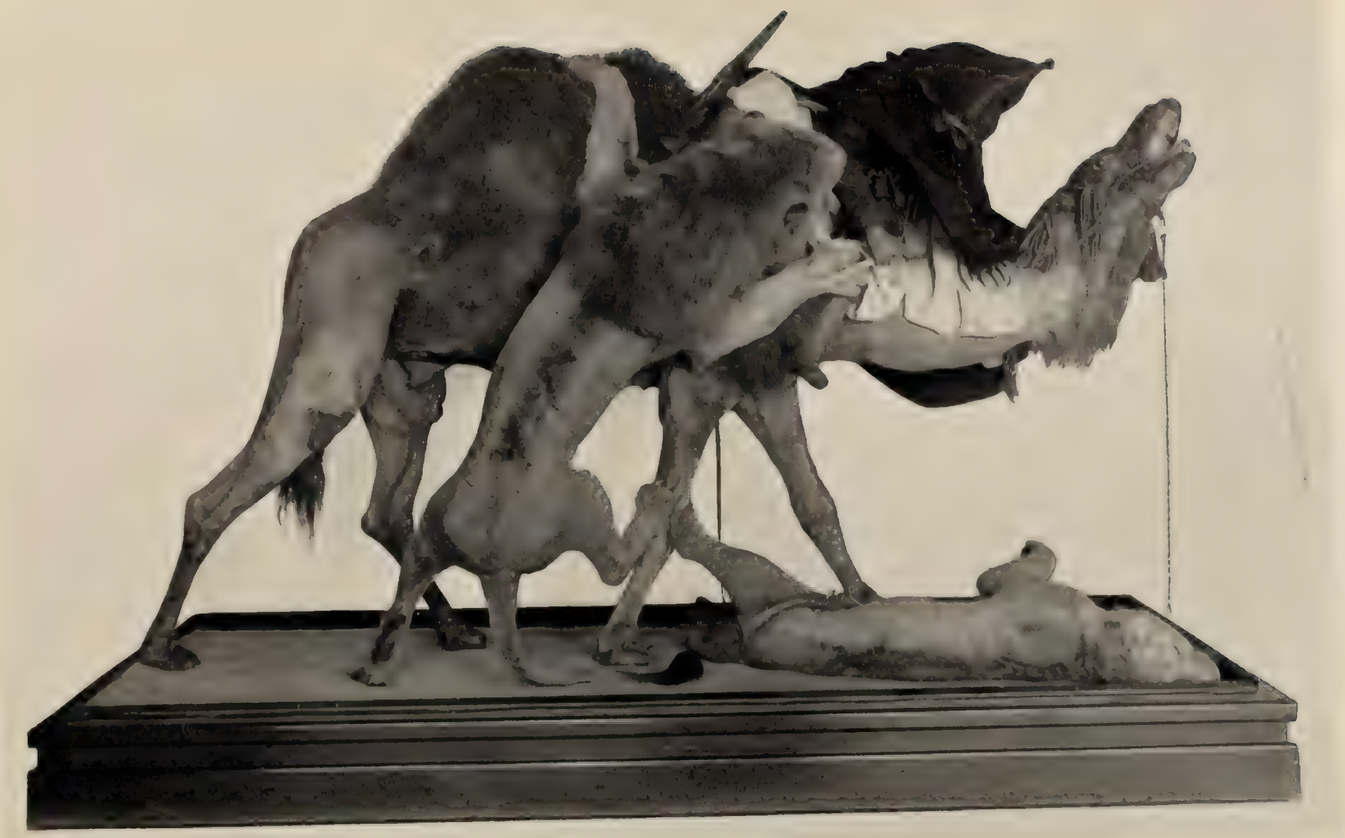
DIRECTOR OF THE BRITISH MUSEUM FROM 1884 TO 1898

Sir William Flower probably did more than any other man to change the character of museum exhibits and make them attractive as well as instructive. He not only planned the exhibits and gave his personal attention to their installation, but in some instances he prepared the specimens himself. In this country like credit should be given to Dr. G. Brown Goode, who was an ardent admirer of Flower and his work in the British Museum

ROBIN REDBREAST GROUP IN THE BRITISH MUSEUM

private individuals and they were mainly heterogeneous assemblages of bright-plumaged birds brought together from the four quarters of the globe and shown simply because they were pretty.

So far as we are aware, the introduction of groups into public museums was due to the influence of an enthusiastic private collector, Mr. E. T. Booth, of Brighton, England, who devoted a large part of his life to making a collection of British birds, mounted in varied attitudes, with accessories that copied more or less accurately the appearance of the spot where they were taken. As Mr. Booth wrote, "the chief object has been to endeavor to represent the birds in situations somewhat similar to those in which they were obtained; many of the cases, indeed, being copied from sketches taken on the actual spots where the birds themselves were shot." These groups were intended to be viewed from



ARAB COURIER ATTACKED BY LIONS

Mounted at the *Maison Verreaux*, Paris, for the Paris Exposition of 1867. This was the first group in the American Museum of Natural History and was displayed for some time in the old Arsenal Building, Central Park. At present it is owned by the Carnegie Museum, Pittsburg

JULES VERREAUX

Naturalist, Explorer, Taxidermist, Founder of the *Maison Verreaux* that led to the creating of Ward's Natural Science Establishment

the front only and were arranged in cases of standard sizes, assembled along the side of a large hall. The collection, which was begun not far from 1858, was bequeathed to the town of Brighton in 1890, and is known as the Booth Museum, and we earnestly hope that it may endure for many years to come.

Montagu Brown of Leicester adopted the methods of Mr. Booth and a little later, in 1877 or 1878, through the instrumentality of R. Bowdler Sharpe, the first small "habitat group" of the coot was installed in the British Museum, then at Bloomsbury Square. Now it is rather

interesting to note that some naturalists who are best known by their scientific work, and are usually regarded by the public as being of the dry-as-dust type, were among the earliest advocates of naturalistic methods in museum exhibits. Thus, to Dr. Sharpe, whose enduring monument is the *British Museum Catalogue of Birds*, and to Dr. Gunther, best known for his systematic work on fishes, we are indebted for the introduction of groups into a great public museum and for obtaining for them the recognition of a scientific institution of long standing.

BLACK-THROATED LOON
One of the nesting groups of British birds in the British Museum

The installation of bird groups in the British Museum made good progress under the administration of Sir William Flower, who took especial interest in the educational side of museums and in the introduction of exhibits that were attractive, as well as instructive, to the general visitor.

The first group in the American Museum, an Arab courier attacked by lions, was purchased in 1869 and shown in the old Arsenal building in Central Park, then the home of this institution. This group may have been theatrical and "bloody," but, as a piece of taxidermy, it was the most ambitious attempt of its day. Moreover it was an attempt to

show life and action and an effort to arrest the attention and arouse the interest of the spectator, a most important point in museum exhibits. If you cannot interest the visitor you cannot instruct him; if he does not care to know what an animal is, or what an object is used for, he will not read the label, be it never so carefully written. The Arab courier group was prepared under the supervision of Jules Verreaux, the French ornithologist and African traveler, for the Paris Exposition of 1867, where it was awarded a gold medal. This group may have suggested the combat between a lion and tiger, displayed in the Crystal Palace, or that, as well as a similar group formerly in the Calcutta Museum, may have originated independently. The last mentioned group illustrates the importance and effect of something that attracts attention: when the Dalai Lama visited the Calcutta Museum, it soon became apparent that he was looking for some particular object, and it later developed that this was the fighting lion and tiger whose fame had traveled into far distant Tibet.

It is worth noting here that the *Maison Verreaux* suggested to Professor Henry A. Ward the possibility of establishing a similar institution in the United States; whence the well-known Ward's Natural Science Establishment at Rochester, New York. And we cannot help feeling that Ward's Establishment had much to do with the history of animal groups. Hither came and hence departed many a man who directly or indirectly did much to advance the art of taxidermy and make possible the existing order of things. Named according to the time of their coming, Hornaday, Webster, Wood, Critchley, Turner, Denslow, and Akeley were all graduates of the old Establishment. Perhaps some of them do not like to be considered as taxidermists, but we can hardly call my friend Wood, whose birds lack nothing save voice and movement to make them seem alive, an animal sculptor, and we hope no one will take offense at being called a taxidermist. If he who delves among books in various dead and living languages to decide which of the numerous many-syllabled names some small creature is rightly entitled to bear does not object to being called a taxonomist, he who works upon the skins of creatures great and small should not object to the rightful name of taxidermist. So taxidermist let it be for the present, or until a better name is coined.

As there are so-called sculptors, who are mere makers of figures, and will be that, and that only, to the end of their days, so there are taxidermists, men like Akeley, Clark and Blaschke, who are sculptors in every sense of the word. And in some ways their task is more difficult than that of the sculptor who deals only with plastic clay, for the taxidermist has not merely to prepare his model, but to fit over it a more or less un-

yielding hide, a hide that does not conceal the defects of the model but has defects of its own to be hidden. Probably no one who has had actual experience in mounting large mammals would question this, though probably few visitors realize the great progress that has been made in the mounting of animals, particularly large mammals. Not very many years ago animals were most literally stuffed—suspended head downward and rammed full of straw, often until they could hold no more. Then came the making of a manikin of tow and excelsior; next the manikin of wire-netting and papier-maché, and finally the modeling of the animal in clay, copying all the folds and wrinkles of life, the molding of this in plaster and in this mold making a light and durable form, or manikin, upon which the skin is deftly placed.

Manikin of Wire Cloth and Papier-Mâché. By Remi and Joseph Santens. Photograph to illustrate strength of modern manikin

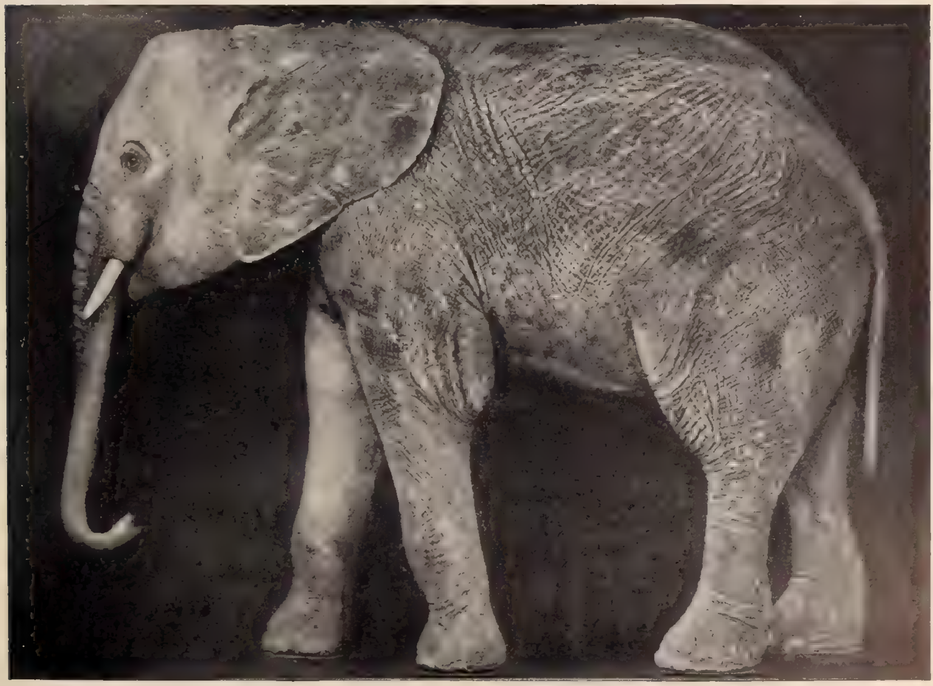
Here again Mr. Akeley has improved upon himself and perfected an entirely new plan for mounting large mammals whereby they are at once more readily modeled, infinitely lighter and vastly more permanent.

Thus methods changed and improved, by far the greatest advance being due to Akeley, who devised the light, strong manikin just alluded to, now in general use. There were various tentatives by others, and it should not be forgotten that many years ago C. J. Maynard employed a plaster cast made from a clay model and that years before this Peale made a manikin of wood, the limbs being carefully carved to give the muscles the swell proportionate to their action: this method he used especially for animals that had not an abundance of hair.

Unfortunately, it seems never to have occurred to the users of plaster that museum specimens are moved about and plaster casts can be made light and strong. Hence they made their manikins solid, or almost solid, with the result that it required an effort to lift so small an object as a fox, and took four strong men to handle a deer, while the specimens were racked by their own weight and wreaked damage to everything with which they came in contact.

Group of Orang-utans in the American Museum. Collected and mounted in 1880 by W. T. Hornaday. This was the first large mammal group in the American Museum [Manikin of excelsior and tow]

This cut, reproduced from a wood engraving in *Harper's Weekly*, is a reminder of the time when half-tones were unknown



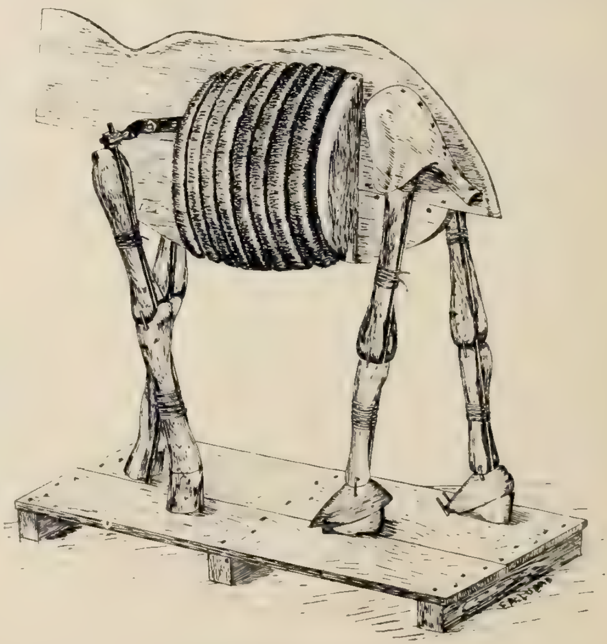
African Elephant Mungo in United States National Museum. Mounted by W. T.

Papier-mâché manikin for an orang-utan. By Remi Santens

I know not who mounted some of the pieces, fair to look upon, that it has been my misfortune to handle during the past few years even, but I do know that I have many times and oft vigorously cursed their perpetrator and wished that he who devised the process had died in early infancy.

The group of Arab and Lions was followed about a decade later, 1880, by the group of orangs collected by Hornaday, mounted by him shortly after his return from a two years' collecting trip around the world and presented to the Museum by Robert Colgate.

This again leads us to note that the energy of Dr. Hornaday had much to do with the formal introduction of animal groups into the American Museum of Natural History and recognition of their place in museum work, because Jenness Richardson



The framework of Mungo

BISON COW AND CALF

A detail of the Group of American Bison mounted in 1889 by Jenness Richardson, Head of the Department of Taxidermy, American Museum of Natural History, from 1886 until his death in 1891

was a pupil of Hornaday, and Rowley in turn a pupil of Richardson, and by them and under their supervision was begun the series of groups now justly famous.

These early groups did not find their way into museums without protest, as may be imagined from the remarks of Dr. Coues quoted on a previous page, but in 1887 the first group of mammals was installed in the United States National Museum, and this was followed a year later by a large group of bison.

The other day, when listening to the protest of a curator against the withdrawal of a certain group from exhibition, we wondered if he remembered another protest against the introduction of a bone that a coyote might have some excuse for action. Verily *tempora mutantur*.

An important factor in the evolution of groups and their introduction into museums was the development of the art, for art it is, of making accessories, for without the ability to reproduce flowers and foliage in materials that would at once have the semblance of reality, and endurance under the vicissitudes of temperature in the intemperate zone in

which most museums are located, half the charm and value of groups would be lacking. For progress in this direction we are indebted primarily to the Messrs. Mintorn of London and their sister, Mrs. Mogridge, who reproduced the foliage in the groups of birds in the British Museum, and later came to New York to carry on the same work for the small bird groups,[1] though their methods have been replaced by one devised by Akeley.

Prior to this wax leaves and flowers were made of pure sheet wax and were necessarily fragile, though in many cases really very beautiful. The art of making them was one of the accomplishments of artistically inclined ladies half a century or more ago and directions for making them may be found in Godey's Lady's Book and Peterson's Magazine, interspersed with directions and patterns for slippers and other worsted work.

Foliage of such fragile character was naturally not fitted for use in Museum groups, and the only leaves to be had by the aspiring taxidermist of 1880 were the heavy opaque cloth leaves made by manufacturers of millinery supplies, which at least had the merit of durability.

The Orang group in the American Museum of Natural History was provided with such leaves, and they were, at the end of thirty-five years' service, replaced by more accurate copies of the foliage of the Durian.

The earliest bird groups in the American Museum of Natural History, the first of which was very appropriately the American Robin, were made largely after those in the British Museum and installed each in a small case so as to be viewed on four sides. They thus differed from their prototypes in the Booth Museum which, as noted, were intended to be seen from one side only.[2]

They were all groups of small or moderate size and confined to species found within fifty miles of New York City. The time was not yet come, though it was near at hand, for the execution of the large naturalistic groups with which we are now familiar, and Museum officers and trustees would have hesitated to incur the time and cost involved in their preparation.

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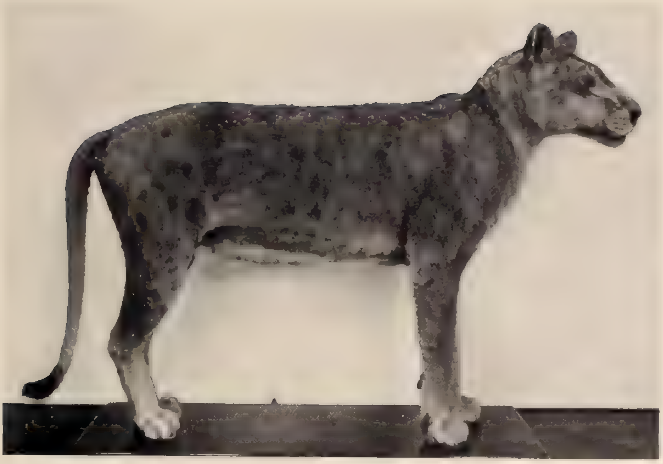
[1]A description of these methods, improved upon by apt pupils, is to be found in *Plant Forms in Wax*, *Guide Leaflet* No. 34, published by the American Museum.

[2]These early American Museum bird groups, thirty-four in number, have been brought together with the other "Local Birds" in the west corridor of the second floor



1—Lioness. An example of early work

2—African Lion. Mounted at the *Maison Verreaux* about 1865

3—African Lion, "Hannibal." Mounted at the American Museum of Natural History by James L. Clark in 1906.

ONCE admitted into museums, a precedent established, and intrenched behind the bulwarks of high scientific authority, groups slowly found their way into all museums and their scope extended to all branches of natural history as fast as opportunity offered and the skill of the preparator would permit. And to-day, from the Atlantic to the Pacific, there is a friendly rivalry among museums as to which shall have the finest groups. Birds lend themselves more readily to groups than does any other class of animals; they combine beauty of form, pose and color with moderate size that permits ease of handling. Hence birds naturally were chosen for the first museum groups, and bird groups still predominate.

Just as naturally mammals followed birds and from mice to elephants have furnished many notable groups and many triumphs—and failures—for the taxidermist. After mammals came anything that the taxidermist or modeler could master—reptiles, fishes, insects and other invertebrates, and last of all plants, which copied by modern methods are ever green and may be made to show their adaptations to environment and interrelations to varying conditions of soil, climate and surroundings.

Yea, the group idea has even been carried into the dim and distant past and in the hall of fossils one may behold a ghostly group of great ground sloths, or farther on, *Allosaurus* feeding upon *Brontosaurus*. And the ground sloths passed out of existence thousands of years ago and *Allosaurus* has not felt the pangs of hunger for over six million years!

Fishes offer some of the most difficult problems; not only does their expression depend almost entirely upon their attitudes, but in many cases there is little of interest in their habits, or small beauty in their surroundings, when they have any. And added to all these things is the ever present difficulty of making a fish suspended in air look as though he were swimming in water. Furthermore in the character of their integument, fishes and amphibians furnish a practically insurmountable problem in the way of mounting, which has led to much friendly discussion as to whether it is better to show a stuffed specimen that does not at all resemble the living animal or a cast that cannot be distinguished from it.

In this instance the writer is entirely on the side of those who offer "something just as good," believing firmly that the object of exhibits is to hold the mirror up to nature and let it reflect an image of nature as she looks when alive, not as she appears when dead and shriveled. And if a cloth leaf and a glass eye are allowable, why not a wax frog and a celluloid fish?

One of the first efforts in the line of fish groups, that by Mr. Alfred J. Klein in the Brooklyn Museum, showing the fishes of a coral reef, is

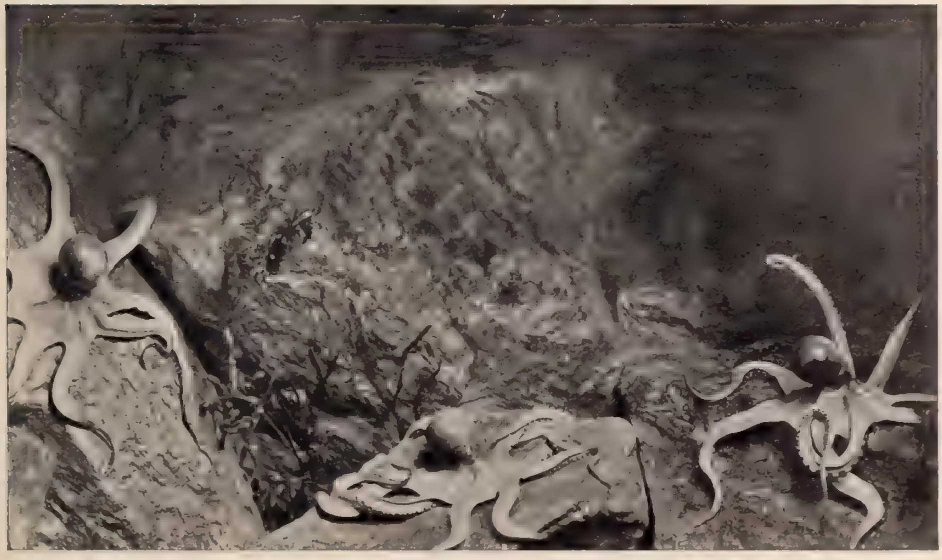
one of the best, partly from the nature of the subject, which affords more scope for attractive surroundings than is usually presented. And while the credit for this group, prepared in 1907, is entirely due to Mr. Klein, yet it really dates from a memorandum written in 1893 after an interview with Dr. Goode, "make a group of red snappers with natural sur-

THE WHARF-PILE GROUP

Marine group in the American Museum by Ignaz Matausch and other preparators under the supervision of Roy W. Miner, 1914. It shows the sponges, hydroids, sea anemones and other invertebrate animals with which wharf piles in favored localities are crowded below low-water mark

roundings." It embodies principles, carried to great perfection in the habitat groups, that were independently worked out in the construction of a group of octopus, forming part of the exhibit of the United States National Museum at the Chicago Exposition of 1893. Painted background connected with the foreground, rounded corners and overhead

PORTION OF THE PADDLEFISH GROUP
In the American Museum of Natural History



OCTOPUS GROUP

This group was prepared by Dr. F. A. Lucas for the Chicago Exposition of 1893 and is at present in the United States National Museum. The animals were modeled in clay and cast in "cathcartine," a mixture of glue and gelatin

lighting were all used in this small group, and while in comparison with what has been done since, it now seems a very crude little affair, yet it contained the germs of the beautiful Orizaba group.

The curved, panoramic background and overhead lighting—borrowed consciously or unconsciously from our cycloramas—permit the last touches in the way of illusion and control of light, regardless of the time

VIRGINIA DEER IN THE AMERICAN MUSEUM

Virginia deer, American Museum of Natural History, mounted by Mr. Carl E. Akeley in 1902. This is an example of work that has made modern taxidermy an art. The work of the taxidermist is in a way more difficult than that of the sculptor, that is, he must not only make a model of the animal in life-like pose, but must then with great art fit over this model the unyielding skin of the animal

of day. The octopus group embodied also another idea, brought to great perfection here by Miss Mary C. Dickerson, that of making a single mold serve for making many individuals. In the octopus group the animals were cast in gelatin compound and bent into diverse attitudes; to-day casts are made in wax, warmed and worked into many poses; a case of the parallel development that occurs in methods as well as in nature.

HOWLING MONKEYS

In the Museum of the Brooklyn Institute of Arts and Sciences, mounted by Mr. J. William Critchley. It is a group whose main purpose is to show the varied attitudes of the animals. Such groups preceded the large naturalistic groups which combine artistic effect with instruction and so greatly enhance the educational value of museums

THE BIRD ROCK GROUP

The first large bird group. This was made in the American Museum under the supervision of Frank M. Chapman in 1898 but was never installed as he had planned

THE ORIZABA GROUP

One of the more recent of the large bird groups in the American Museum and typical of the "habitat groups." Constructed by William Peters and other preparators of the Museum, background by Bruce Horsfall

PART OF THE LAYSAN ISLAND GROUP

Made for the State University of Iowa by Homer R. Dill. This group shows a portion of the albatross rookery on the little island of Laysan where millions of birds find a home in the middle of the Pacific Ocean. Background by Charles Corwin

The first bird groups, those in the British Museum and those here, were, if we may borrow a phrase once familiar, now almost obsolete, pre-Raphaelistic in their character—exact copies of the spot or surroundings where the animals were taken. The plants were counted and plotted on a diagram; sod, roots and shrubs were dug up and transported, often in the face of great difficulties, to the museum where the group was to be established, and there assembled in the exact and proper order of occurrence. The next step was the habitat group, and here is where Dr. Frank M. Chapman comes into the story, for it is to him that we owe the series of nature pictures known by that name.

The habitat group does not copy nature slavishly, even though an actual scene forms the background; it aims to give a broad and graphic

presentation of the conditions under which certain assemblages of bird life are found, to bring home to the observer the atmosphere and vegetation of some typical part of the country. But save in exceptional cases, the foreground does not exactly reproduce any given bit of country, although it does copy the plants and shrubs found there. How these groups were prepared, what journeyings by flood and field they involved are told by Dr. Chapman himself in *Camps and Cruises of an Ornithologist* and very briefly in the leaflet describing these groups.

The habitat groups thus involved a slight departure from nature, in that while the background depicted an actual scene, the foreground was often generalized and this involves the whole question of how far it is allowable to depart from actualities. May we combine animals from different localities or show together those taken at different seasons? Shall we fabricate our soil and "fake" our trees? Personally the writer believes that all these things are permissible, with certain restrictions, nay, in some instances, must be done, not merely to make a group at all, but to enhance its educational value. For example, a bison in his winter coat may be introduced into a group with the mother and young and a baby moose placed with an antlered bull—in no other way can you complete the life cycle and tell the whole story.

Dr. Chapman found it physically impossible to bring away the water-soaked nests of the flamingoes; Mr. Cherrie found equal difficulty with

THE LOWER CALIFORNIA LIZARD GROUP

The third of the series of reptile groups in the American Museum, made in 1913 by Frederick H. Stoll and other preparators of the institution under the supervision of Miss Mary C. Dickerson

CYCLORAMA GROUP OF MAMMALS OF NORTH AMERICA

In the Museum of the University of Kansas, a group prepared by L. L. Dyche to show North American mammals from plain to mountain and from temperate to Arctic America

THE FOUR SEASONS—SUMMER

In the Field Museum, Chicago. By Carl E. Akeley, 1902

the sodden nests of the guacharo birds, while to carry off the cave in which they were found would have defied even Hercules in his prime. Here certainly, fabrication is a necessity; and if so much, why not more? If we cannot import a tree from the forests of Venezuela, let us "adapt" an ironwood from Vermont, whereon a colony of howling monkeys may disport themselves. In this case it is the animals and not their surroundings that are to be emphasized, and the accessories are a matter of secondary importance, merely a setting.

The first large group, the Bird Rock group, placed on exhibition in 1898, was not definitely planned as a habitat group, but merely as a picture of part of a famous and impressive bird colony and to make "a permanent record of this characteristic phase of island life." The Cobb's Island group was the next and the first real habitat group to be constructed, this subject being chosen partly because it provided a large and interesting group at small expense.

Year after year this series of groups has been extended, covering the country from east to west and north to south, until room is left for but one more, and that, it is hoped, will include the bird life of the Arctic regions.

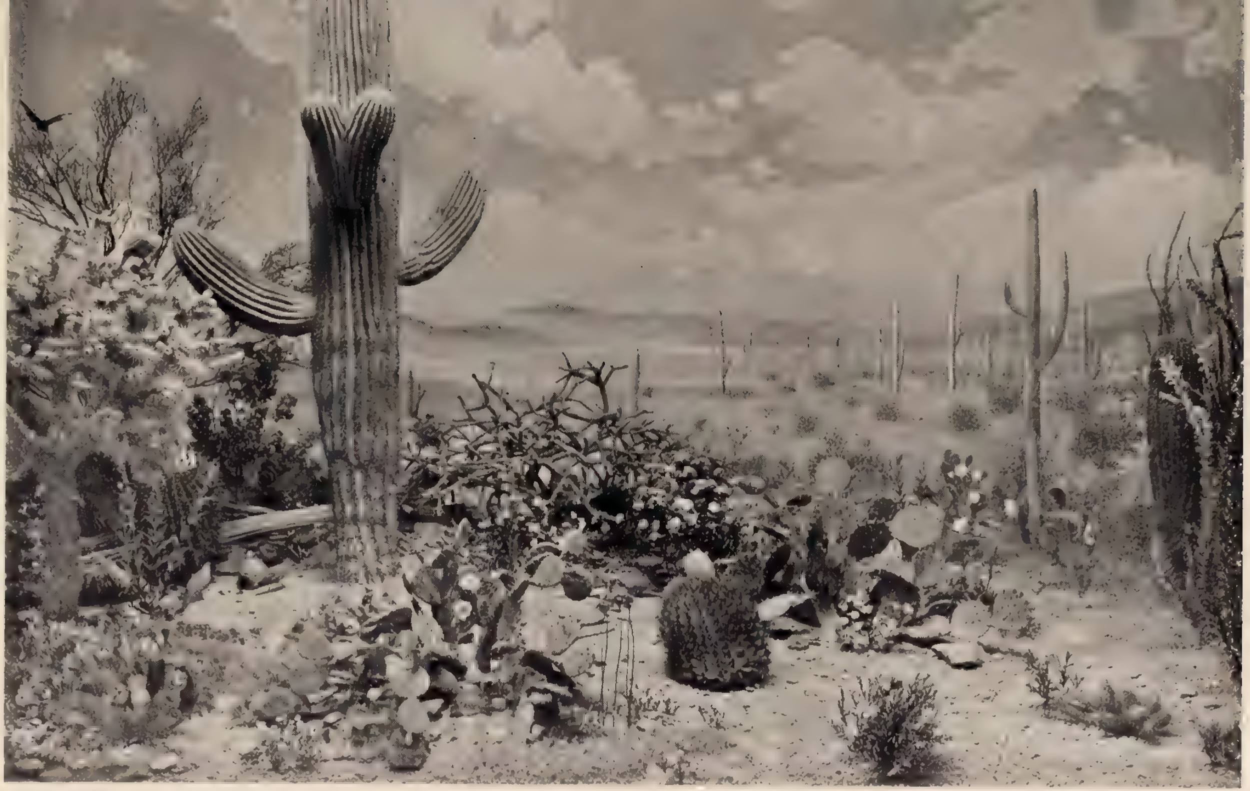
The Bullfrog, Giant Salamander and Florida groups, particularly the latter, belong in still another category and may be termed synthetic, or life study groups, bringing together in one composite picture a number of animals that probably would not be found in so small an area at any one moment of the season depicted, but might all be found there at some moment of the season. Such a group may, or may not, repre-

HEAD OF MOUNTAIN SHEEP, IN THE BROOKLYN MUSEUM. Mounted by Remi Santens, for many years at Ward's Establishment, now at Carnegie Museum, Pittsburgh

THE BUTTERFLY GROUP

The Monarch Butterfly—migrating

Butterflies, numbering more than 1200 specimens, mounted and placed by Charles Wunder, accessories by W. B. Peters.



DESERT LIFE GROUP

In the Brooklyn Museum, planned by Edward L. Morris, executed by Antonio Miranda and Herbert B. Tschudy, 1917. This was intended to be a strictly botanical group to illustrate the plant life of a desert and to form part of an extensive exhibit in which groups should do for plants what the Habitat Groups of Birds do for animals.

After the death of Mr. Morris the plan for a botanical exhibit was unfortunately abandoned and a group of antelope, mounted by Mr. Robert H. Rockwell, then added

sent a particular spot; it does depict the natural conditions under which the animals are to be found and shows them engaged in the most characteristic and interesting of their varied occupations. In this, the day of moving pictures, we may say that as the moving picture condenses into five minutes' time the events of days or weeks, so these groups depict in a few square feet of space the life and happenings of a much larger area.

The group in its latest form is to be found in the Museum of the University of Kansas, where it includes a great part of the Museum, a special section having been constructed to contain a large cyclorama where the various North American animals from plain to mountain and from temperate to arctic America may be viewed approximately as they would be seen in nature.[1] Somewhat similar is the Laysan Island group, executed for the State University, Iowa, by Mr. Homer R. Dill, where the visitor gazes about him at the imposing assemblage of albatrosses and other sea fowl, while beyond the blue Pacific stretches to the horizon. Aside from these the bison and moose groups in this Museum, made by Richardson and Rowley, are the largest that have been made, and although they have been on exhibition for twenty-four and twenty years respectively, they compare favorably with those of to-day.

The African mammals, by Mr. Carl E. Akeley, in the Field Museum, are among the finest of their kind for pose and character, but the "Four Seasons," in the same museum and also by Mr. Akeley, depicting the Virginia deer in spring, summer, autumn and winter, represent high-water mark in this direction, combining as they do pictorial beauty with scientific accuracy of detail. It was while engaged on these groups that Mr. Akeley perfected the method of making the manikin, or artificial body on which the skin is placed, so as to combine strength, lightness and durability, and also devised methods for the rapid reproduction of leaves and a compound stronger and more durable than wax. The need for making leaves in large quantities is shown by the fact that in the "Four Seasons," the summer group alone called for seventeen thousand leaves.

Such, briefly, is the story of museum groups; they have grown from the little box containing a pair of birds and a square foot or two of their immediate surroundings, to entire colonies of flamingoes and albatrosses and the broad sweep of land or sea shown in the Orizaba and Laysan groups. No one man can justly claim credit for the beauty and accuracy of such groups as may to-day be seen in our larger museums; many have contributed to this perfection and some stand preëminent among the rest. To each and all his just meed of praise. Some, whose work might

[1]This prepared by and under the direction of L. L. Dyche, is an amplification of his ideas as shown in 1893 in the Kansas Building at the World's Fair.

THE GROUND SLOTH GROUP
The American Museum of Natural History

now provoke a smile, labored hard and earnestly in the face of many discouragements to lay the foundations on which we build to-day. Some of whom the present generation has never heard, held out a helping hand to the youthful would-be taxidermist and by aid and encouragement started many of our best men on their career, and some, keen observers of nature, endowed with artistic spirit and possessed of technical skill, have perfected what others began.

Great progress has been made, especially in our newer museums, in the installation of habitat groups, notably those of mammals, during the seven years that have elapsed since the Story of Museum Groups was written. The most noteworthy among them are those prepared by Mr. John Rowley in the California Academy of Sciences, showing the characteristic large mammals of California. Not only are these groups not restricted in size but they have the great advantage of being installed in a hall planned and built for their display, points wherein Mr. Rowley has worked under conditions more favorable than those enjoyed by his predecessors. However, he expects to do even better in the series planned for the Los Angeles Museum.

The Public Museum of Milwaukee has placed on exhibition a number of groups, among them a series illustrating the habits and habitat of the races of man found in North America. In this connection should be noted the remarkably fine series of the Iroquois in the State Museum at Albany installed in 1915 and 1916, which reach high water mark in this direction. That habitat groups will, in the future, form an essential part of every important museum seems undoubted, but the question arises, though it is propounded very timidly, if there is not danger that the matter of groups may be overdone. Not every animal is worthy to be included in a habitat group and while it is the duty of a museum to present to the public Nature in her fairest forms, yet this should not be done to the exclusion of other important matters.

Furthermore the space demanded by groups, with the attendant cost of building and administration, necessarily limit groups, especially in our smaller institutions.

AMERICAN MUSEUM OF NATURAL HISTORY

FOR THE PEOPLE

FOR EDUCATION

FOR SCIENCE

AMERICAN MUSEUM OF NATURAL HISTORY

PLANTS OF WAX

By LAURENCE VAIL COLEMAN, M.A.

GUIDE LEAFLET SERIES, No. 54 FEBRUARY, 1922

AMERICAN · MUSEUM · PRESS

HACKENSACK MEADOW GROUP

Showing a great variety of foliage

A PORTION OF THE BULLFROG GROUP
Showing Pickerel Weed

Plants of Wax

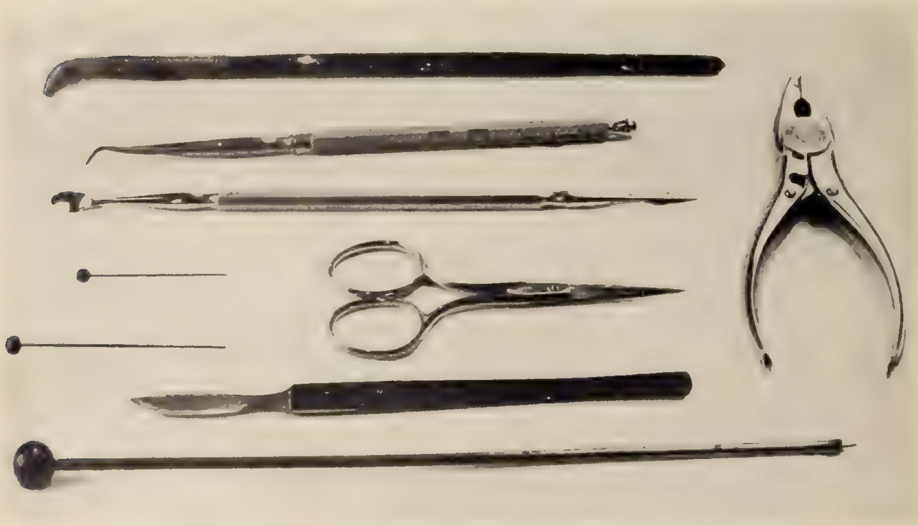
How They are Made in The American Museum of Natural History

By Laurence Vail Coleman, M.A.

Plants of wax have become familiar to museum goers chiefly in connection with habitat groups of mammals, birds and reptiles. In fact, the impressiveness of a group often depends as much upon the accessories which enter into its composition as upon the specimens which it features, and therefore the making of artificial foliage has become an important branch of work in a museum's studios.

The following account explains how plants are made in the American Museum. The method employed for leaves was devised and patented by Carl E. Akeley, and this brief exposition is published with his consent.

The principal materials required are bleached beeswax, cotton batting of good quality, annealed and stiff iron wire of various sizes, and a few tools, such as are shown in the cut. Fingers must do the rest; tools will not give mechanical ability any more than brushes and colors will make an artist. For delicate leaves, or the petals of flowers, mousseline de soie, the mysterious "fabric" of the Mintorns, is needed. This was formerly used in making leaves, but has given way to the more practical and economical method of Akeley. The agate burnisher, a tool used by gilders, is rather a luxury and a home-made tool of brass or iron will serve the purpose. The use of this is to smooth down rough spots,



TOOLS USED IN MAKING LEAVES AND FLOWERS OF WAX

or points, and to weld together leaves like those of the pitcher plant that are made in two or more parts.

Do not be discouraged if your first efforts are not successful, or not as successful as you expected. Printed directions can give you only general principles; something depends on natural aptitude, much on care and patience. Try something easy first.

WAX LEAVES

In making artificial foliage the individual leaf is the preparator's first concern. A fresh leaf makes the best model, though one preserved

in a bath of formalin and glycerine[1] may be used. By word and picture let us follow the reproduction of a leaf.

MAKING A SQUEEZE MOLD

The original leaf is placed upon a bed of clay around which a clay wall is set up and the enclosure so formed is poured full of plaster

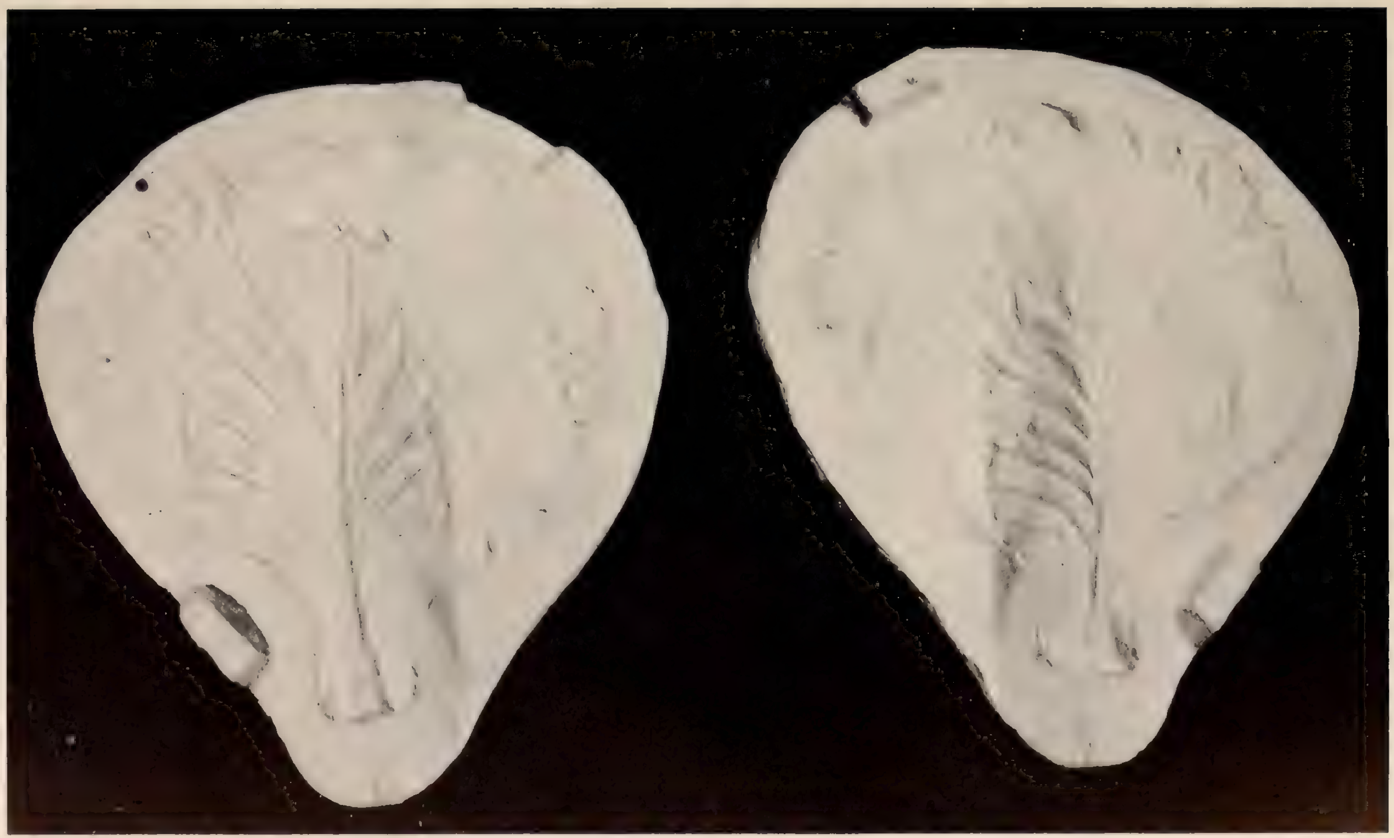
THE LEAF, RESTING ON A CLAY BED
Ready for Making the First Half of the Mold

[1]A mixture of formalin 15 parts, water 35 parts and glycerine 50 parts is best for prolonged preservation of foliage. Leaves immersed in a stronger mixture for a few days and then removed and dried will usually retain their form and if so treated may be recolored and used for exhibition, but the result is seldom satisfactory.

which covers one side of the leaf and soon sets. The clay is then removed, leaving the leaf and the plaster together. Two notches or keys are cut in opposite edges of the plaster to receive the keys of the second part of the mold and to prevent the two parts slipping on one another. The margin around the leaf is brushed with clay water or soap solution to

THE LEAF, RESTING ON THE FIRST HALF OF THE MOLD
Ready for Making the Second Half

prevent the next layer of plaster from adhering to it, and for best results the soap is then swabbed off and a film of stearin applied; another wall is set up around the leaf and its plaster bed and into the little basin thus



THE TWO HALVES OF A SIMPLE MOLD

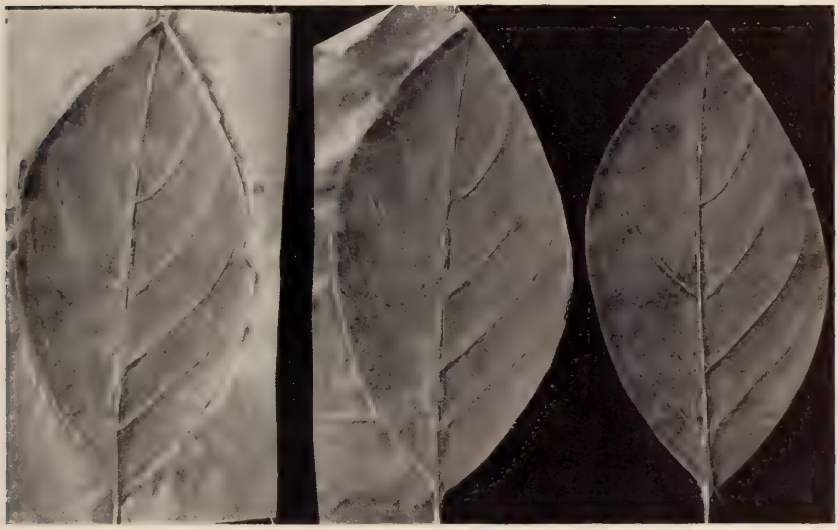
formed is poured plaster which covers the second side of the leaf. When it sets, the two blocks of plaster may be separated and the leaf between them will have left its impression on the inner face of each. It will be seen that each key on the first block has now its mate on the second, for tongues of plaster from the last-poured mass have filled the notches cut in the first one. Thus the two parts interlock and fit together in one position only.

THE WAX LEAF READY FOR TRIMMING

The mold is now set aside to dry and before using hardened by boiling in a strong solution of borax for about twenty minutes or soaking in melted paraffin for about the same time. Molds treated with paraffin give the best impression but are a little difficult to use on account of the tendency of the wax to stick to them. In case a mold is going to be used a great many times, it is best to soak it in linseed oil for five minutes and let it dry for a week or two.

CASTING A WAX LEAF

When leaves are to be cast from a squeeze mold, the mold must be soaked in hot water and used while warm and moist. Heat keeps the wax from chilling till it fills the mold and moisture prevents it from adhering to the plaster. A film of cotton is laid upon one side of the mold—better the concave side if either one is so. A piece of cotton-covered hard iron wire[1] is laid along the line of the midrib, with its end projecting



THREE STAGES IN TRIMMING A VERY SIMPLE LEAF

to form a stem, and if the leaf be a thick one more cotton is laid on top. Melted wax, tinted green with oil colors, is then poured upon the cotton and the upper part of the mold squeezed down upon it. The whole is plunged into cold water, opened and the cast removed.

The wax should be bleached beeswax to which should be added about a tablespoonful of Canada balsam to each quart of melted wax, the object of the balsam being to toughen the wax. Wax should be

[1]For small leaves the cotton covered millinery wire of commerce is employed, but for larger ones it is desirable to use iron wire of a larger size. The wire is tapered with a file or on an emery wheel and then wrapped with cotton by twirling it through the fingers.

melted in a double boiler, such as is used for cooking oatmeal in order to avoid burning the wax and to lessen the danger from fire.

A HEAVY COMPLEX LEAF
Showing the Wire Supports on the Under Side

The oil color is thinned with a very little turpentine and thoroughly stirred into the melted wax; this gives the body color of the leaf to be imitated.

It will be found that pressure aided by capillarity has forced the wax into a thin sheet which has engulfed the cotton and the wire so

that neither can be seen, and that the excess of wax has run out around the leaf. The manipulations of casting may be performed in a few seconds.

Much time is saved by using three molds in rotation so that while one is in use a second may be warming in hot water and a third with its cast may be cooling in the cold bath.

A COMPLETE LEAF OF THE PITCHER PLANT
And the Molds Used in Making One-Half of It

A Pair of Molds is Needed for Each Half of the Leaf, the Keel, Shown in the Picture Being Made on One of the Halves

In the case of large, heavy, and, especially, deeply scalloped leaves such as occur on many tropical plants, it is necessary to make a somewhat elaborate complicated framework, such as is indicated in the figure.

by twisting together a number of wires so that one underlies each arm or part of the leaf. These wires are wound with cotton batting or gauze, tapering from their junction with the midrib to the tip.

In making these large leaves, it is often advantageous for two persons to busy themselves with a single mold, one person pouring the wax and the other manipulating the mold and removing the casts. For large parti-colored leaves two colors of wax, perhaps green and red, may be poured into the same mold.

METAL SQUEEZE MOLDS

A mold is sometimes attached to a large hinge or frame by means of which it may be opened or closed after the fashion of a lemon-squeezer. Metal molds— half type metal and half bronze—may be employed if a large number of leaves is required, and such a mold must always be attached to a hinged frame.

FINISHING A WAX LEAF

The cast as it is taken from the mold must first be trimmed. Scissors are usually employed but the operation is not a simple one if the edge of the leaf be serrate. In this event, the scissors, which have been warmed, are jerked along, alternately cutting ahead and edging to the side. Then with a warm tool imperfections are removed, and finally the leaf is shaped between the fingers.

The wire which projects from the base of the leaf is wrapped with a strip of mousseline-de-soie (a gauze of the utmost delicacy) dipped in wax. Once more the tool is applied to the stem to obliterate all traces of successive windings and the leaf is finished save for a final coloring.

The manner of assembling leaves upon their stems is determined by the habit of the plant, the manner in which the leaves are arranged around the main stem. The leaves of herbs are lashed with thread to a wire of proper size to represent the main shaft of the plant, and the joints are wrapped with gauze, the windings being continued along the shaft. Stiff iron wire should be used for this purpose, and to insure a neat piece of work the end filed to a long taper. Leaves of trees are usually treated in the same way, only the tender twigs being reproduced, for the larger woody twigs need not be fabricated, but in their natural state serve as a base to which the wax tips are attached.

In fastening leaves to the woody twigs, a hole is bored diagonally through the twig with a fine drill, if you are fortunate enough to have one, or with a triangular glover's needle held in a pin vise or set in a little wooden handle. The leaf wire is passed through the hole, bent down along the twig, and wrapped with gauze. In the absence of gauze, thin, tough brown paper, cut in narrow strips, will do fairly well.

When the work of assembling has been done, the final touches of color are applied. A large air-brush which delivers a spray of oil color thinned in turpentine is really a necessity where leaves are to be made in considerable numbers; where only a few are wanted color may be stippled on with a brush or wad of cotton batting and good results may often be obtained by rubbing in dry color.

Frequently ten thousand leaves are needed for a single group, but it is rarely necessaryto make more than half a dozen sizes of one kind, so hundreds of leaves may be cast from a single mold.

Blades of grass are cut from heavily waxed gauze and are modeled by folding them lengthwise over the edge of a knifelike strip of tin fixed in a wooden base. Very little manipulation is required. No rib is used,

but each blade from a short distance above the base is rolled about a wire and several blades are then attached to a heavier wire stem.

In making cactus, the spines are removed and a piece mold made of the plant or of the various branches. In the case of such a form as the barrel cactus, the body is often made hollow to save wax and while still in the mold, backed with a lining of plaster and burlap.

WAX FLOWERS

Success in making artificial flowers depends largely upon ingenuity

A SPRAY OF DOGWOOD
A Very Simple Flower

in the application of a few general principles, though to make small flowers on an extensive scale necessitates the use of dies, such as are shown in the cut and unfortunately, the making of dies calls for the services of an expert machinist. Large or medium-sized flowers, poppies, for example, can be made without any special appliances.

The first step is always to dismember the natural flower in order to determine its construction, and ordinarily it will be found to consist of a central bulb-like pistil surrounded by slender stamens, a set of petals

DIES USED IN MAKING FLOWERS

collectively termed the corolla framing this heart and a calyx covering the junction of the flower with the stem.

When the pistil is large enough to be of any consequence it is cast upon the end of a wire which is later wound with waxed gauze to the size of the stem. The stamens are usually long filaments, each bearing a nodule or anther at its tip, and they are usually imitated with waxed threads or wires of which the tips are dipped in wax. To imitate stamens which are short, stout and numerous, it may be practicable to fray or lacerate one edge of a strip of waxed gauze and so to make a sort of limp comb which may be wound around the stem with the points upstanding.

The conspicuous and often highly colored corolla is either a group of separate petals or a cup formed by their fusion. The daisy and the morning-glory illustrate respectively these two conditions. Separated petals, if small, are usually cut or stamped with a metal die from waxed gauze, and for convenience they may sometimes be made in one piece, joined together at the bases. Large petals are usually cast just as if they were leaves on a basis of gauze, or, if large, cotton batting, and are then welded to the stem one at a time. A "one-piece" corolla is split down one side and laid out flat as a pattern for cutting, stamping or casting similar pieces. Each artificial corolla is then curled around the stem like a cone and the two adjoining edges are welded together with a hot tool.

The basal calyx frequently has the form of a star, which may be punched out and the stem slipped through a hole in its center, but sometimes it is composed a large petal-like parts which must be made separately and attached to the stem.

The ground color of all parts is mixed into the wax of which they are made, and the finishing tints are applied by hand or with an air-brush which delivers liquid color as a spray.

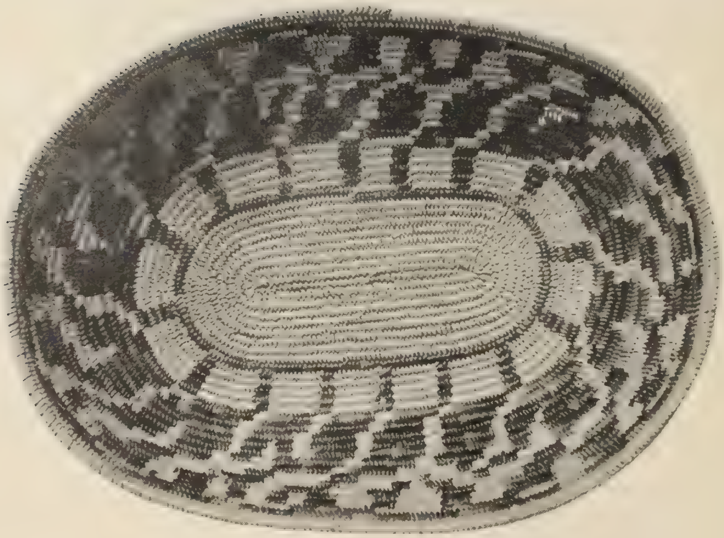
AMERICAN MUSEUM OF NATURAL HISTORY

BASKETRY DESIGNS

OF THE MISSION INDIANS

By A. L. KROEBER

GUIDE LEAFLET SERIES, No. 55 JULY, 1922



Two Handsome Mission Baskets

BASKETRY DESIGNS

OF THE MISSION INDIANS

By A. L. KROEBER
University of California

AMERICAN MUSEUM OF NATURAL HISTORY
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MISSION INDIAN BASKETRY DESIGNS

By A. L. Kroeber.
University of California

Visitors to a museum are often impressed by the degree to which basketry looms up among the exhibits illustrating the life of the Indians of California and many other primitive peoples. Not only are baskets relatively more important owing to the want of many implements of furniture and utensils to which we are accustomed, but they are absolutely more numerous, varied, and showy than among ourselves. In many cases it is the very lack of development of other arts that has led to the special development of basket making. Among the California tribes the best of mechanical energy and ingenuity was exercised in this one branch of manual dexterity. It is not that the Indian possessed some mysterious faculty, some inborn gift, through which he could surpass us; but that he manufactures so few other things that he is able or compelled to devote a disproportionate amount of his interests in this special direction. There is little doubt that civilized people, if they took up the matter seriously, would outdistance the savage at his own game, in basket making as in other undertakings. Yet, when it comes to the actual fact, baskets are a comparative side-issue to us, notably in comparison with other textile products, especially cloth. The result is that basket making remains a sort of starved stepchild of civilization, whereas it is the favorite son of many savage cultures.

This growth of basketry at the expense of other arts is particularly exemplified in aboriginal America by the tribes of California and the nearby regions. These peoples have always been reckoned among the most backward of American Indians in the general level of their attainments; but there is also a unanimity of agreement that their baskets excel those of most other tribes, in fact are probably preëminent on the continent, if not in the world. Living entirely in the Stone Age stage, the California Indians knew nothing of vessels of metal. The majority of them were ignorant of pottery making; and their wood working was so little developed that had they suddenly decided to replace some of their baskets by utensils of wood, they would have been very hard put to it to produce even partially adequate implements. People who build their houses of thatch, slabs of bark, or dirt thrown over a framework of sticks, and who navigate on rafts of rushes instead of in timbered boats, have obviously left their carpentering instinct undeveloped. It is a curious commentary on the mechanical limitations of these tribes that in spite of

the perfection of their hand woven textiles, they have been content to refrain from making the next step in the natural evolution of the industry, namely, to weave on a loom and thus produce simple fabrics.

It is perhaps significant in this connection that their basketry art is wholly in the hands of women, who spend a great part of their lives, probably an average of several hours a day, in this occupation. They seem better able than men to provide the steady patience which is called for. The work never becomes quite automatic—in the making of a really good basket the attention can not wholly wander from the work in hand, even if the weaver has many years of experience. At the same time there is no heavy strain on the attention, and no concentration of energy is called for. These requisites seem to be better satisfied by the feminine temperament. We have then this curious situation: the general industrial backwardness of the California Indians is exemplified by their leaving the most important of their industries to their women; but the women have so far advanced this industry, that the men have no hand in the peak of attainment of the native culture on its material side.

With the art of basketry in such flourishing condition in this region, it was inevitable that the imagination of the more gifted individuals should be stimulated and new inventions made. As the native population is cut up into a great number of local groups more than a hundred tribes or linguistic units have been recognized in California—it might further be expected that newly devised methods would often spring up independently in separate localities, and that the final outcome would be a number of distinct arts in various parts of the area. This is exactly what has happened. Neighboring tribes, it is true, have often borrowed a new method of manufacture or a new style of decoration from the group that originated it; but on the whole, intertribal communication in aboriginal California had a limited range and such spread of new ideas remained restricted. The consequence is that we encounter about half a dozen quite diverse basketry arts in California; in addition, anyone whose interests lead him to closer study is usually able to learn to distinguish the particular style of many single tribes.

Among these independent styles one of the most distinctive is that evolved by the Mission Indians, as they are generally called, the groups that inhabit the coast and mountain regions of Southern California from Los Angeles to San Diego.[1] They derived their name from having been

[1]Gabrielino and Fernandeño; Mountain, Pass, and Desert Cahuilla; Juaneño; Luiseño; Cupeño; Northern and Southern Diegueño; and some of the Serrano. The Diegueño are of Yuman stock, all the others Shoshonean or Uto-Aztecan. The ware of the Chumash is closely affiliated but not identical.

brought more or less thoroughly under the influence of the Franciscan missionaries during the last third of the eighteenth and the first third of the nineteenth century. Their basketry is not as fine in texture as that made by some other California Indians; but they did, and do, good, even work when they wish to, and evince a peculiar originality and boldness in decoration that makes their ware of interest. This basketry may accordingly be described as reduced to the minimum on the technical side, but quite specially elaborated along certain ornamental lines; a quality that has often commended it to artists and collectors.

That a people should skimp technical aspects while evidently eager to develop the aesthetic ones, may seem unusual. Yet it must be noted that while the Mission Indian women do some poor work, their efforts on the whole are not directed so much to avoiding labor by fudging the manipulation, as to simplification of process. In other words, they seek a maximum of effect with a minimum of means; and this in itself argues a considerable accomplishment. Even if one aims at nothing more than a tolerable product, it takes some skill to achieve this with the mechanics of the work cut to the bone; and the best Mission ware is much more than tolerable.

This limitation of means in Mission basketry comes out in the matter of weaves. This is a complicated subject when followed out in detail; but it may be summarized by stating that the world over there are three principal types of basket weaving. The first, which includes checker work, wicker work, and twilling, is essentially a cloth weave made free hand in coarse materials. The basis of it is the simple *in-and-out* weave. That is to say, a single cross strand at a time is worked over and under the longitudinal ones. The second type is *twining*, which occurs in many varieties, all of which have in common the fact that two or more cross strands are introduced at the same time. This involves the fact that besides being worked in and out among the longitudinal elements, they must also be twined among each other; whence the name. The third process is that known as *coiling*, and, as has often been pointed out, is in strict accuracy a process of sewing rather than of weaving. The foundation elements are wrapped or lashed together, and this can be done only with the aid of an awl or needle. There is no set of parallel warps to serve as a basis, but the foundation strands or rods coil in a continuous spiral.

Now of these three processes, the first and simplest or in and out weave, was not used at all in Mission Indian basketry. This is the more remarkable because this weave is particularly rapid and satisfactory

where materials of the type of cane or bamboo are available, and Southern California is a country in which cane is native. The second, or twined process, was known to the Mission Indians but remained very much stunted Their twined baskets served only the most ordinary domestic uses, and were coarse, irregularly spaced in open work, and undecorated. While we acknowledge their existence in passing, we may eliminate them from further consideration here. The coiling process was thus the only one of much consequence in this art, and it is significant that whereas coiling can be executed in a variety of ways, as on a foundation of one rod, two rods, three rods, rods and splints, etc., the Mission tribes restricted themselves, deliberately as it were, to only one variety: namely, a multiple foundation consisting of a bundle of grass stems. In this sole technique they worked a variety of forms and achieved varied pattern effects.

The limitation of materials is no less remarkable. There are several dozen plants growing in Southern California abundantly enough to have been available as basket materials, and some of these, such as yucca and willow, were actually used in baskets by tribes of other regions. Yet practically all Mission basketry is made in three materials only: a particular species of grass serving as foundation, and either sumac or a rush as wrapping.[1]

Even in the matter of forms there is a greater restriction than is customary among the neighboring aborigines. Certain types of baskets were made everywhere in the California area except by the Mission tribes. We can account for their absence here by definite causes. Some centuries ago, the art of pottery making crept into southern California from Arizona and New Mexico, where it had flourished among the Cliff-Dwellers and Pueblos for thousands of years. Being rather settled in their habits of life, the southern Californians were able to utilize clay vessels to an extent which would have been impossible—on account of breakage—among a nomadic people. Their cooking utensils were therefore made of pottery, rendering it unnecessary for them to manufacture the watertight baskets in which the other California Indians did their cooking by means of hot stones. Then, a special burden basket, a deep, conical affair, shaped to sling on the back, such as the other tribes used for carrying loads, was dispensed with because the southern Californians had evolved the carrying net. This was a sort of small hammock, the ends connected by a rope or band passing over the forehead, while the

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[1]*Epicampes rigens; Rhus trilobata; Juncus sp.*

bag of the net passed around the shoulders and hung over the back. Into this net a comparatively shallow basket, or at least a flat-bottomed one, could be set without spilling. In this way the peaked burden basket of the other tribes was eliminated.

When now we consider the effect of the technical limitations on the ornamentation, we find its results apparent in three directions.

First, the invariable coiling on a bundle of grass stems produces a certain thickness of texture. Through the fact that it must be a bundle, the group of stems cannot well reduce below a certain diameter, say a sixth of an inch. This means that the wrapping stitches which are sewn around and through the bundle must also be of considerable length, and tend naturally to be of some breadth. Small, delicate designs could consequently be worked only with difficulty: they would quickly reveal themselves as inadequate in effect. The Mission tribes therefore took the other tack, frankly made most of their designs large and heavy, and developed a good deal of feeling for the impression which can be obtained by patterns of blocks or gross masses, instead of depending on intricacy of arrangement of small elements.

Secondly, the coarse stitches could scarcely be made to look as even as fine ones. This circumstance cultivated in the mind of the weaver a disregard for sharp edges and nicety of pattern. She must often have had difficulty in bringing out the two sides of a design element exactly even, especially when she was carrying it around the curvature of the vessel. The outcome was, in some cases, an indifference to exact balance; whereas more daring workers met the situation by plunging deliberately into designs which avoid symmetry. This is a rather rare condition in basketry, and must be looked upon as one of the salient traits of the pattern decoration of Mission ware.

In the third place, the color scheme was affected by the nature of one of the basket materials to which the southern California Indian women had become addicted. The Juncus rush which is one of the two materials showing on basket surfaces, comes in a great variety of colors, from a cream white to a dark brown, with intermediate shades of yellow, reddish, olive, and gray. In fact, the stems vary so much that considerable care is required if it is desired to give a basket a background of uniform color. Here again there are two avenues open, and both were followed. One was to be discriminating, and to match as closely as possible the stems that were worked into one basket. The other was to renounce the attempt at uniformity and openly strive for a patchy color effect. A great many Mission baskets are mottled almost like a mackerel

skin, and the effect is distinctly pleasing. In some cases the pattern is emphasized by shading the background in contrast with it. If the pattern is dark, the stitches and the background immediately in contact with it are carried out in specially light shades of the rush, as if to relieve the design.

Then, this variable rush which made dyes practically unnecessary — the only color artificially produced in Mission ware is black—stimulated the color imagination as such. The result is that, although Mission designs are basically built up of simple and often crude elements, they are in many cases worked out in two colors. There is an illuminating contrast on this point with tribes that employ other materials and techniques. The ware of the Pomo region, for instance, is far more delicately made, and the designs lighter and more intricate; but the pattern is always of one color only, either red alone or black. In short, the Pomo weavers suppressed whatever impulse they may have had in the direction of color elaboration and specialized in the development of forms; whereas the Mission Indians were generally content to compose their patterns without much complexity of design, but to add to their liveliness by variety of color.

Like many primitive peoples these Indians were very little inclined to turn their basket patterns into pictures. The decoration remains geometric and can nearly always be analyzed into fundamental elements of triangles, quadrilaterals, or bars. It is true that basketry, like cloth, does not lend itself readily to free-flowing lines and curves; but that such effects are not impossible is shown by the ware produced in some parts of the world and occasionally by the Mission Indians themselves. On the whole, however, we can commend the aesthetic feeling which led the weavers to avoid such attempts; which from the very nature of the technique can never be preëminently successful as pictures, and which usually lose in decorative effect ten times as much as they gain in realistic representativeness. Most of the few Mission designs that can be recognized as being pictures of something—rattlesnakes, birds, human beings, or the like—occur in comparatively modern pieces made after the weavers discovered that many white people take more interest in even a poor picture than in a beautiful geometric design that carries no meaning to them.

We are so accustomed to think of the Indian as backward and childlike that it is a great temptation to feel pleased, as it were, over his failures. The more crudely he does a thing, the more typical it is likely to seem to us, and the more eager we are to seize upon it. Of course this

crudity of his is especially emphasized when he attempts to imitate ourselves. In this matter of designs the Indian quite generally knew his limitations, and, left to himself, at least in many tribes, did not attempt to decorate by pictures, reserving these for his religious communications. He had however, like all human beings a sense for the beautiful; and dumb though he might be in expressing this in words, he instinctively knew the difference between an object having aesthetic value and one lacking it.

We must remember too that, owing to the very poverty of his life as compared with ours, the Indian was conservative, so that when a given style had once grown up it tended to flourish for centuries. This permanence would sooner or later make it probable that even in small communities artistically gifted individuals would be born who would add their contribution of quality or talent to the prevailing style. They would thus set up a standard of attainment which would serve as a model and could be pretty successfully imitated by the mass of weavers who set to work with less creative imagination but with much willingness to do their best. To every Indian group, however small, art consequently represents a truly national tradition. The best that many preceding generations have had to offer has gone into it. This is why such arts, whether they manifest themselves in basketry or pottery or beadwork or carving, almost invariably possess a genuine aesthetic merit no matter how limited they may be. Those among ourselves who possess artistic impressionability find little difficulty in entering into the spirit of such primitive arts. Possibly sometimes we are even more keenly alive to their values than the natives themselves. On the other hand the civilized person who prefers the childish and halting efforts at picture making in Indian textiles or beadwork, is characterizing himself as lacking in feeling for the best that native art really has to offer. He is gratifying a superficial or sensational taste which is not artistic at all.

On the whole the Mission tribes, like many other Indians, are sufficiently imbued with feeling for their own aesthetic products to adhere rather firmly to the tribal styles. The disturbing effect of trade influences is perceptible in this ware, but has not yet cut very deeply. In some respects it has even proved stimulating. The baskets with mottled surface or subtle color effects find a readier sale than those of a severer color scheme. The result is that proportionally more of them are being made, and bolder effects being carried out on them than formerly. It is true that there are fewer Mission Indians than there used to be. Many of the younger generation have gone to school, and the mode of life is

each year coming to conform a little more to our own. There can thus be little doubt that ultimately this art will die out. It is far from dead, however; and on many of the little reservations that stud Southern California it is not only the old but also the middle aged women that still produce fine baskets. Even a returned school girl, innocent though she may be of such matters when first coming home, is likely to take up the industry as a means of providing herself with pin money, as soon as she discovers that if she can turn out competent ware in her idle moments, it will bring a satisfactory price at the trader's or from the tourist. In this way, while civilization is on the one hand tending to destroy the integrity of this basketry art, it is on the other helping to keep it alive and is even stimulating it to new developments.

ANALYSIS OF DESIGNS

Figures 1–42

The cross (figs. 1–8) is a native design, as shown by its fundamental form: four blocks surrounding a rectangular space, as in figs. 1, 3, 4.

An elongated checkerboard arrangement occurs in bands (fig. 9), masses (figs. 10–12), and related rectangular forms (figs. 13–16).

Upright rectangles flanked by rows of right-angled triangles are characteristic (figs. 17–19).

An erect diamond with little light window-like spaces in it is shown simple in fig. 20, elaborated in 21–22, distorted in 23–24.

Simple diamonds are frequent, both in patterns and standing free (figs. 25–33). Note the characteristic asymmetries and irregularities in figs. 27–29.

One of the most typical Mission basket designs is a V or pair of spreading horns which are used free, in pattern repetition, and to elaborate other designs. Figs. 31 to 50 all contain this motive recurring through a series of designs of the greatest variety.

Figures 1-42

ANALYSIS OF DESIGNS

Figures 43–84

Figs. 45–47 are notable as three variants on the identical basket, 45 being standard and 47 the extreme of asymmetrical simplification.

Designs deliberately thrown out of balance appear in figs. 57–78. The asymmetry may be barely discernible, as in 66, 67, 68; prominent but yet superimposed on an underlying symmetry, as in 65, 73; or fundamental, as in 60, 62, 76.

Fig. 64, representing a church, is a modern variant of the old native pattern seen in 52 and 53. See Plate I, fig. 1.

Triangles are the basis of designs 79–84. Figs. 81 and 82 evince a pleasing imagination.

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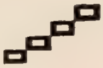

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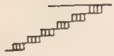

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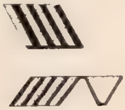

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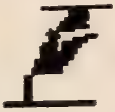

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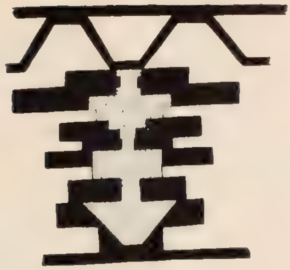
Figures 43-84

ANALYSIS OF DESIGNS

Figures 48, 49, 75, 77, 78, 84

These six figures illustrate some of the more complex basket pattern elements. Figs. 48 and 49 are built on the V or "spreading horns" concept, highly elaborated but nevertheless substantially regular. Fig. 75 is a step pattern, simple in motive, but tantalizingly irregular even within the two and a half repetitions shown. Figs. 77 and 78 are masterpieces of decorative invention repaying the most careful analysis. It should be remembered that designs like these are not outlined in advance but slowly evolved as the basket is built upward. On a small scale, the aesthetic process is similar to that operative in a richly decorated mediaeval Cathedral growing through several generations without an architect's plan.

48



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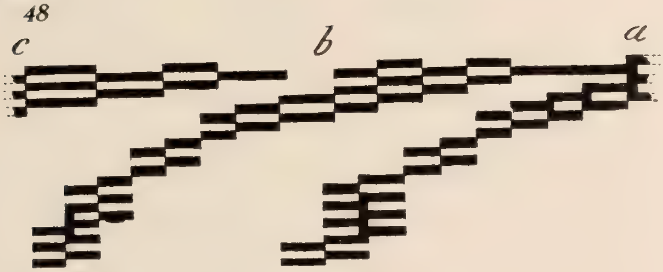

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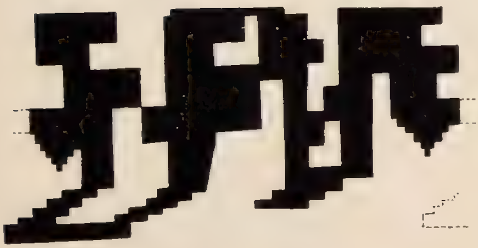

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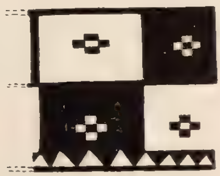

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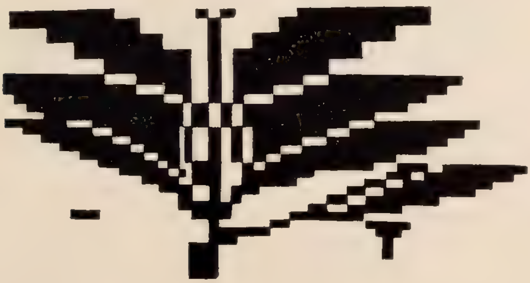

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Figures 48, 49, 75, 77, 78, 84

Figure 85

Figure 86

Fig. 85. The entire design on a flat basket, unusual in its semi-realism, yet handled with definite decorative feeling.

Fig. 86. Designs 18 and 83 are here shown as they actually appear on the inner surface of a shallow basket. The elements occur at uneven distances; they are introduced 5 and 3 times respectively, instead of 4 and 4; and one of them is worked both with and without contained color.

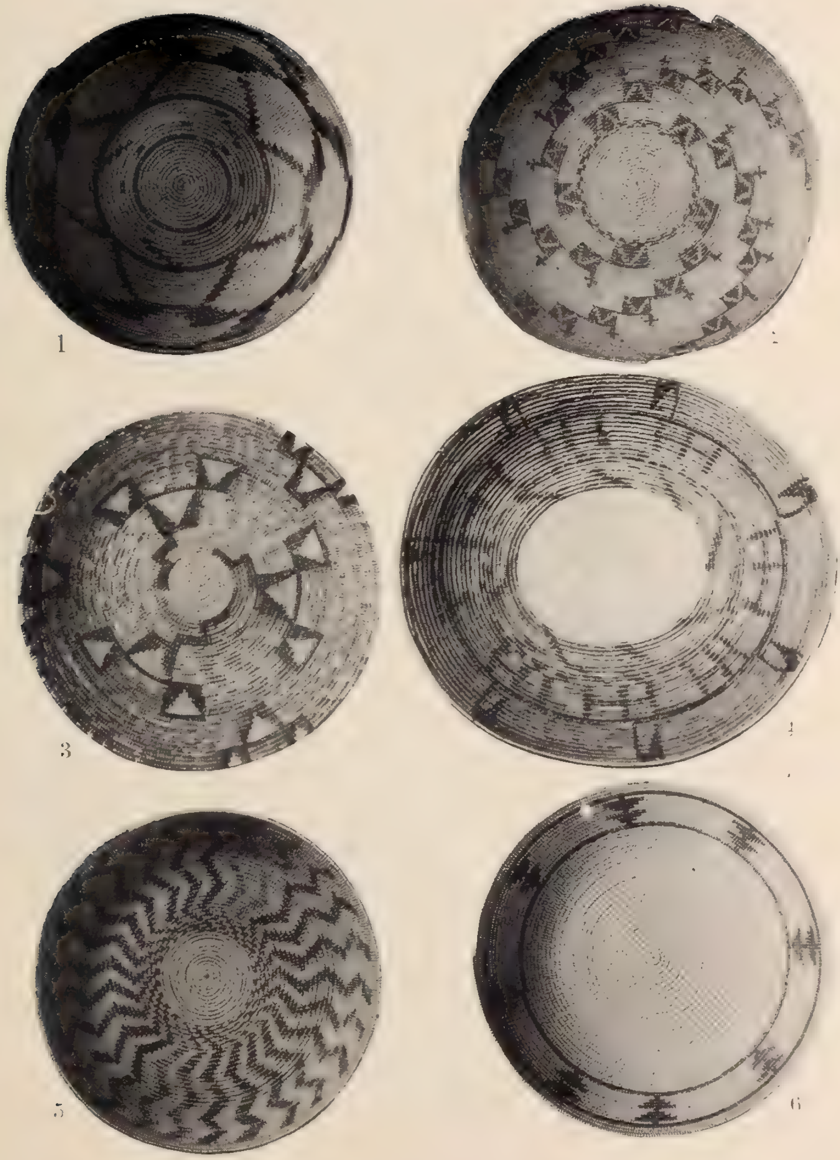

Plate I.

Pattern arrangements on flat and shallow Mission baskets—banded, radiating, spirally diagonal and crossing or zigzag. In fig. 3 the elements are unevenly spaced; in 4 they are irregular; 3 and 5 show varying shades in different parts.

Plate II.

In deep baskets the design elements tend to run grosser than in flat ones: compare especially 1, 2, 3 with Plate I. The design in 4 is saved from crassness by the way its tints slide subtly from light to dark.

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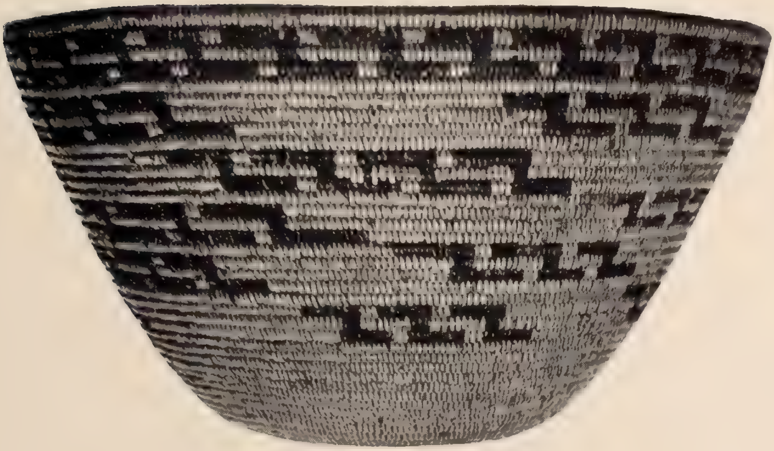

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Plate III.

Fig. 1 shows in detail the characteristic pattern mottling, and fig. 2 typical irregularities in repetition of the design motive.

AMERICAN MUSEUM OF NATURAL HISTORY

THE GEOLOGY OF NEW YORK CITY AND VICINITY

MANHATTAN SCHIST

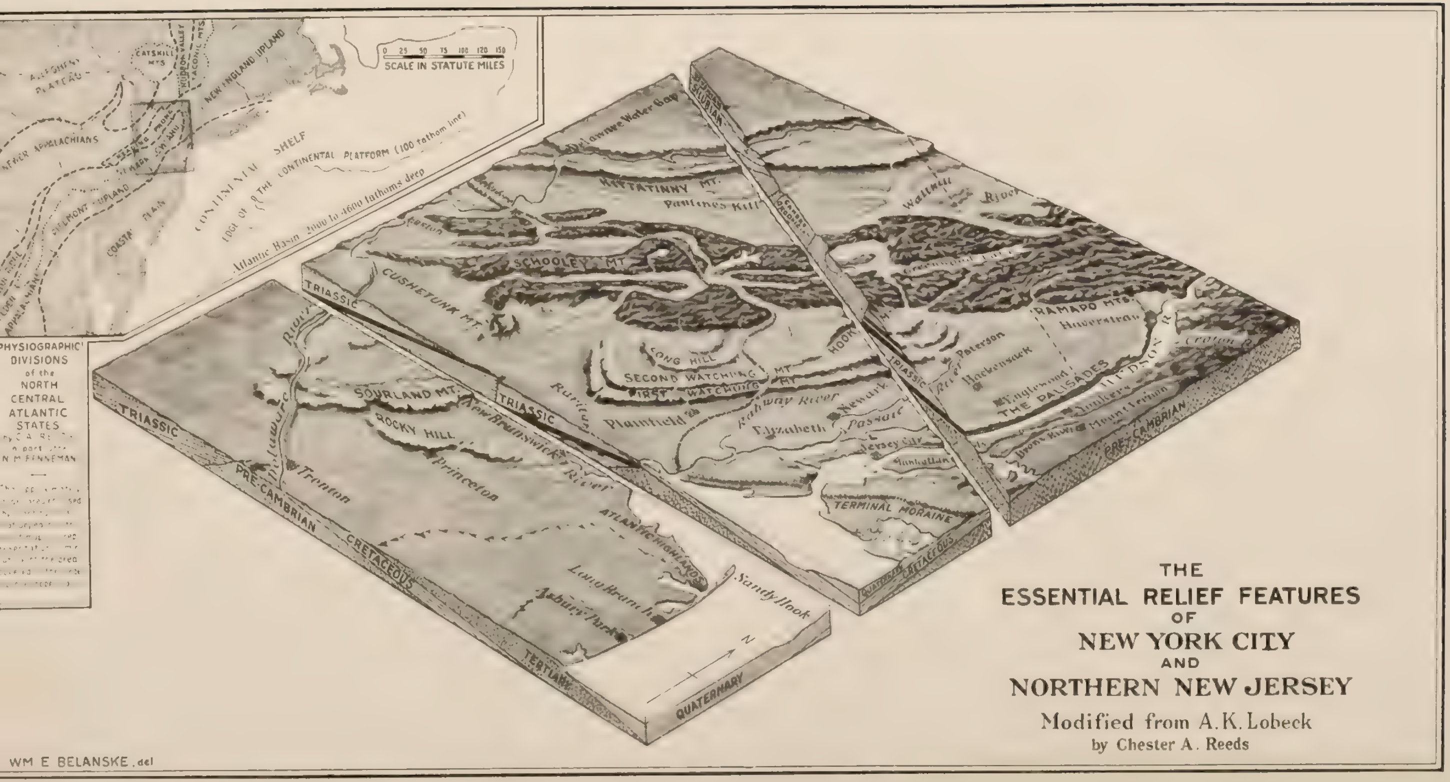
By CHESTER A. REEDS

GUIDE LEAFLET SERIES No. 56

ERRATA

This article was originally published in *Natural History*, occupying pages 430-45 of the September-October issue of 1922. The cross references in the article as reissued are to the original pages, and to assist in locating these references the following substitutions should be made:

p. 430 (on page 1, column 1, line 28) should read *frontispiece*.
p. 434 (on page 5, column 2, line 5) should read p. 4.
pp 436-37 (on page 9, column 1, line 37; on page 9, column 2, line 41; and on page 15, column 2, line 39) should read pp. 6-7.
pp. 441-42-43 (on page 11, column 2, lines 18-20) should read pp. 11-12-13.



DIAGRAMMATIC RELIEF MAP OF NEW YORK CITY AND ADJOINING AREAS

[*Reprinted from* Natural History, Vol. XXII, No. 5, pp. 1-15, 1922]

GEOLOGY OF NEW YORK CITY AND ITS VICINITY

BY

CHESTER A. REEDS*

THE relief features of the New York City district consist of several distinctly different types, which have been developed by natural forces on rocks of unequal hardness Some of the rocks are unconsolidated sands and muds and are of comparatively recent date; others are stratified with alternating hard and soft beds, which have been tilted or slightly folded and are older; still others of the same origin but far older have been so much altered and deformed during certain geologic periods that they have become crystalline and entirely changed in appearance, that is, metamorphosed. Volcanic rocks thick and homogeneous in character have also been injected into the area at different times, some very early, others later, but none very recently. These and some of the crystalline ones form the most resistant ridges. The distribution of the rocks is in the form of belts with a prevailing northeast-southwest direction.

The essential relief features and physiographic provinces of the area are shown in a graphic manner on the relief map, p. 430. They may be summarized as follows:

1. The continental shelf, which represents the submerged margin of the continent, extends eastward from the New Jersey shore for about 100 miles to the 100 fathom line. Beyond that point the sea floor drops rapidly to the great and extensive oceanic depths of 2000–4600 fathoms.

2. The Coastal Plain is that portion of the former submerged continental shelf which has been raised above the sea without apparent deformation. Three well defined elements of this plain appear:

(a) Its inner lowland, partly drowned in Long Island Sound, Lower New York and Sandy Hook bays, extends southwestward along the main railway lines through New Brunswick, Trenton, Philadelphia, Baltimore, and Washington;

(b) Its fall line features appear on the Delaware at Trenton, on the Schuylkill at Philadelphia, on the Potomac at the Great Falls above Washington, D. C., and on the James River at Richmond;

(c) Its cuesta forms the foundation of Long Island, the Atlantic Highlands, and the ragged front making up the hilly belt of southern New Jersey.

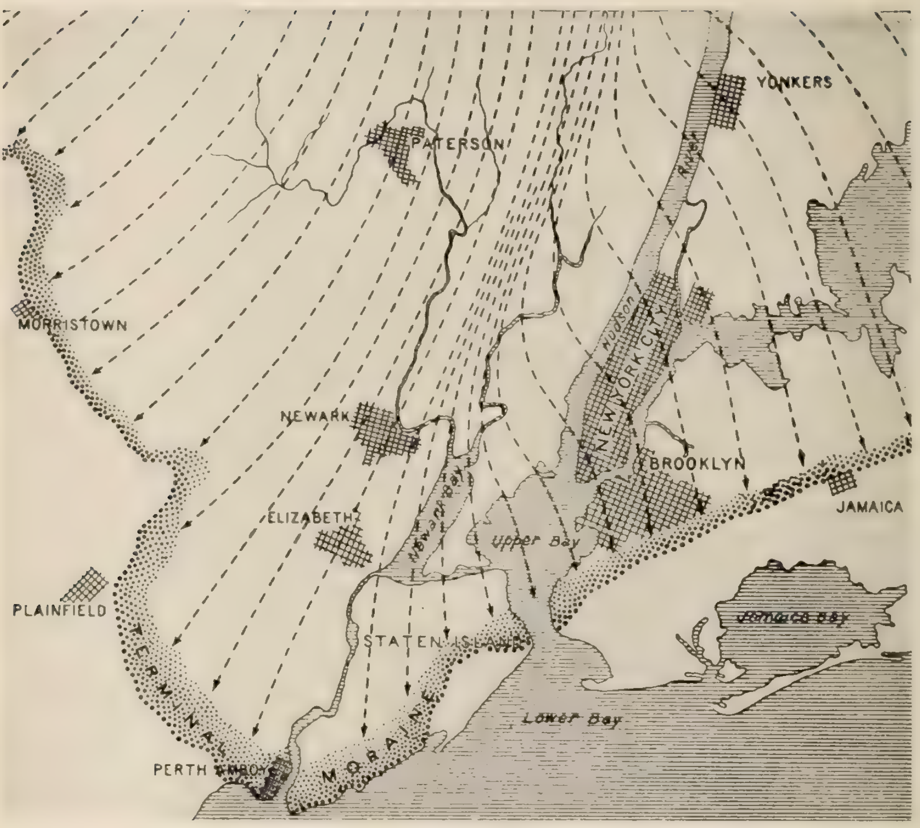
3. The Newark Lowland is a plain developed on inclined weak strata consisting of red sandstones and shales of Triassic age. The intrusive sheets of resistant volcanic rock form the prominent residual ridges known as the Palisades, Watchung, Hook, Cushetunk and Sourland mountains, and Long and Rocky hills.

4. The New England Upland is represented in the district by the Manhattan and Reading prongs. This upland consists of dissected and disordered crystalline rocks. The Manhattan prong extends down the east bank of the Hudson estuary from the Highlands to and including Manhattan Island. The nortd central portion of Staten Island is ah outlier. The Reading prong extends an highlands from the gorge of the Hudsos southwestward across New York ann New Jersey to Reading, Pennsylvania.

5. The broad valley to the west occupied by the Wallkill and Paulins Kill is a part of the great Appalachian Valley, which extends from Birmingham, Alabama, to Lake Champlain. It is one of the prominent subdivisions of the Newer Appalachian physiographic province.

6. The narrow Kittatinny Mountain ridge dipping westward, represents the northeastern extension of the belt of

*Associate Curator of Invertebrate Palæontology, American Museum



Sketch map of New York City and vicinity, showing position of the terminal moraine and directions of the ice movement (indicated by the arrows) during the last or Wisconsin glaciation. After United States Geological Survey

newer and folded Appalachians of central Pennsylvania.

7. The Alleghany Plateau appears west of the Delaware River. Farther north in New York State the Catskill Mountains represent a subdivision of this plateau.

Glaciation: The northern portion of the New York City district has been traversed at least four times by great sheets of ice which moved down from the Labrador center. These continental glaciers modified the drainage and the surface of the land over which they passed. The terminal moraine which represents the southernmost extent of the last ice field appears as a conspicuous ridge consisting of knobs and kettle holes on Long Island, Staten Island, and New Jersey. It continues westward across the United States to the Pacific Ocean near Seattle, Washington.

The drift bowlders and unsorted rock débris in the terminal moraine and northward give a clue as to the direction of ice movement. Large bowlders of crystalline rock from Jamaica and Hollis, Long Island, indicate that they were plucked out of the bed rock in the vicinity of Yonkers, Mt. Vernon, and other places in Westchester County, New York. Glacial-borne pebbles containing fossils and oolites have been found at Broadway and 191st Street. The fossils represent minute fragments of bryozoa and corals, of Devonian age, which are similar to those found at present in the Catskill Mountain region. The oolites, which

The "rocking stone," New York Zoölogical Park, an ice-transported bowlder resting on a glaciated surface

are small, concentric spheres cemented together, resemble fish roe. They, too, came from up-state New York. On Staten Island, Long Island, and Short Hills, New Jersey, many large drift bowlders of sedimentary origin and containing numerous marine fossils were derived from the exposures in east central New York State.

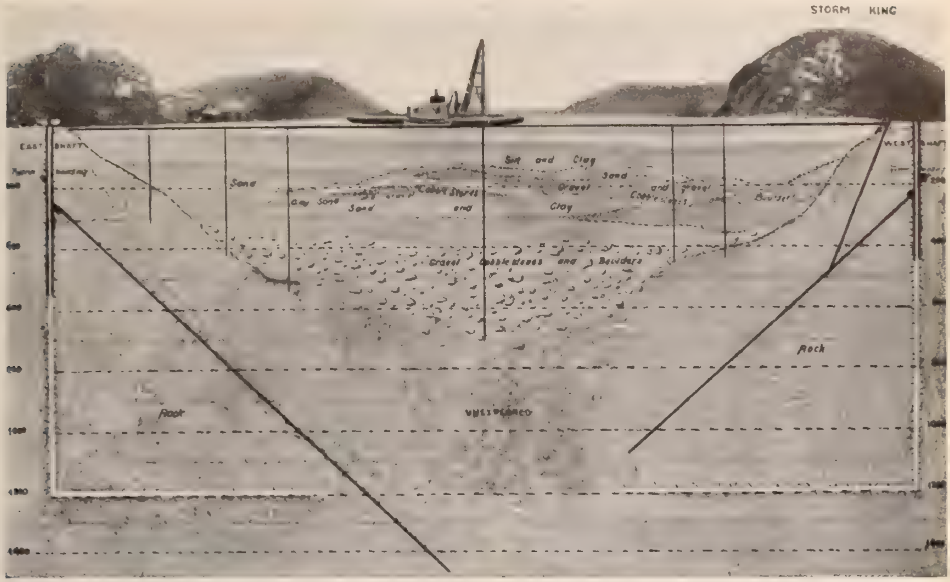
Each of the four continental glaciers of the Pleistocene epoch consisted of ice thousands of feet thick. They not only plucked out huge bowlders the size of a house and transported them long distances, but they also scoured off the soil-cover in many places and left bare rock surfaces, *roches moutonnées*, little deserts in fact, on which no plants other than lichens can grow. A good example of a glaciated surface with an ice-transported bowlder resting upon it is the "rocking stone" in the New York Zoölogical Park, Bronx, figured above.

Rocks held firmly in the base of the ice served not only as abrasives but also as etching tools. Deep parallel grooves in crystalline rock appear at various places on Riverside Drive, particularly on the south side of the Drive where it leaves the Hudson River at about 200th Street. These glacial striæ running northwest-southeast give the direction of ice movement. Many diabase bowlders from the Palisades found in Yonkers and New York City indicate that the ice moved southeasterly, diagonally across the Palisades and the Hudson River, as shown on the diagram.

A stream leaving the front of the glacier oftentimes contained a large volume of water and had considerable transporting power. Hence pebbles,

Exposure of glacial till, containing sand, gravel, and bowlders, in contact with Serpentine rock, at Castle Point, Hoboken. After United States Geological Survey, Passaic Folio, No. 157

sand, and fine rock débris were carried in considerable quantity. In most instances the streams deployed fanwise almost immediately on their emergence from the glacial sheet and the material carried from the ice was dropped close to the margin of the glacier. The fans formed by single streams were usually small, being from half a mile to two miles in radius; confluent fans were larger, varying from one to six miles in radius. The materials are somewhat sorted and stratified and are called outwash deposits. These deposits occur at short intervals along the southern margin of the terminal moraine. Towns built



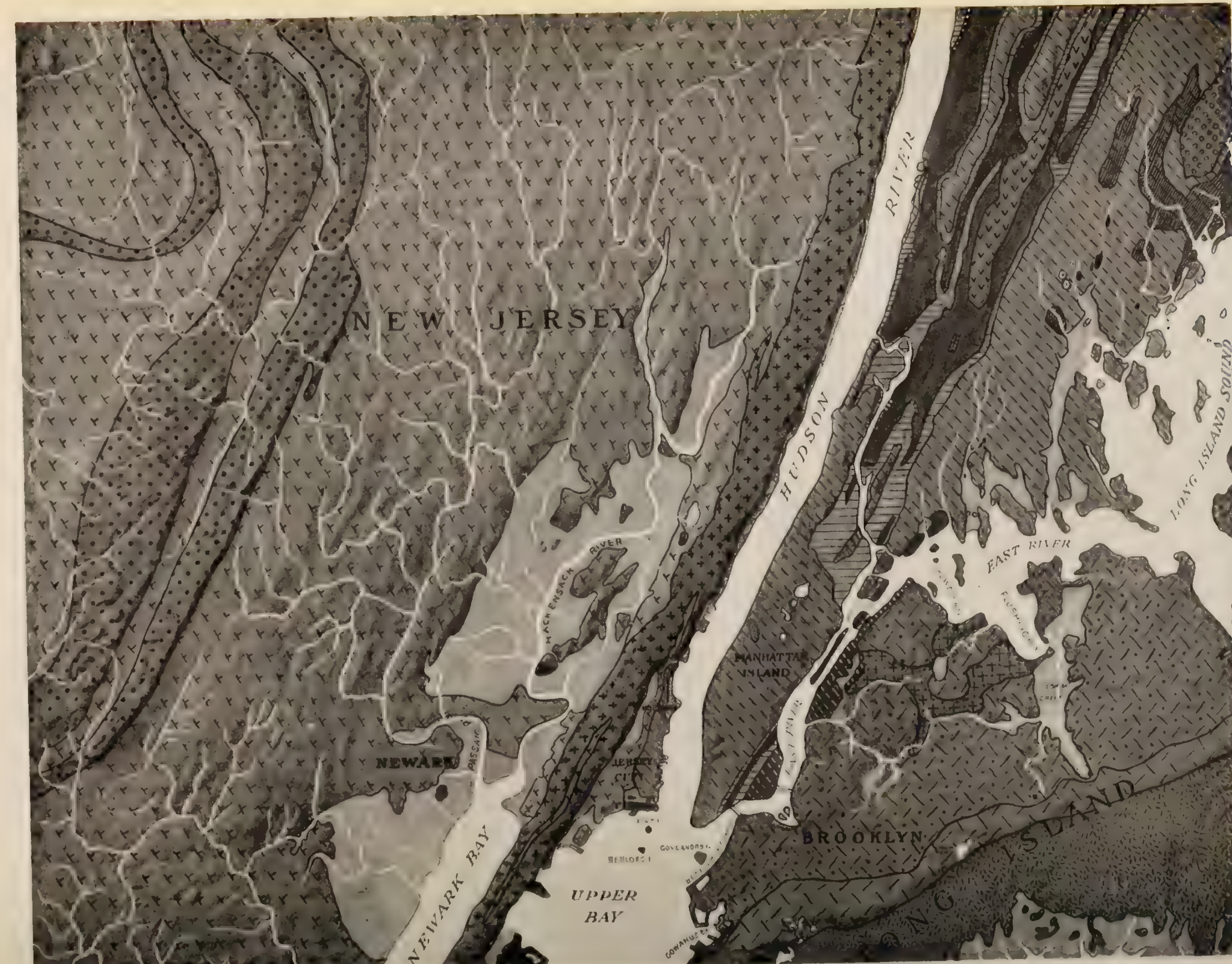
Cross-section drawing of the sediments in the Hudson River at Storm King Mountain, where is located the great siphon of the New York City aqueduct. From *Bulletin 146* of the New York State Museum

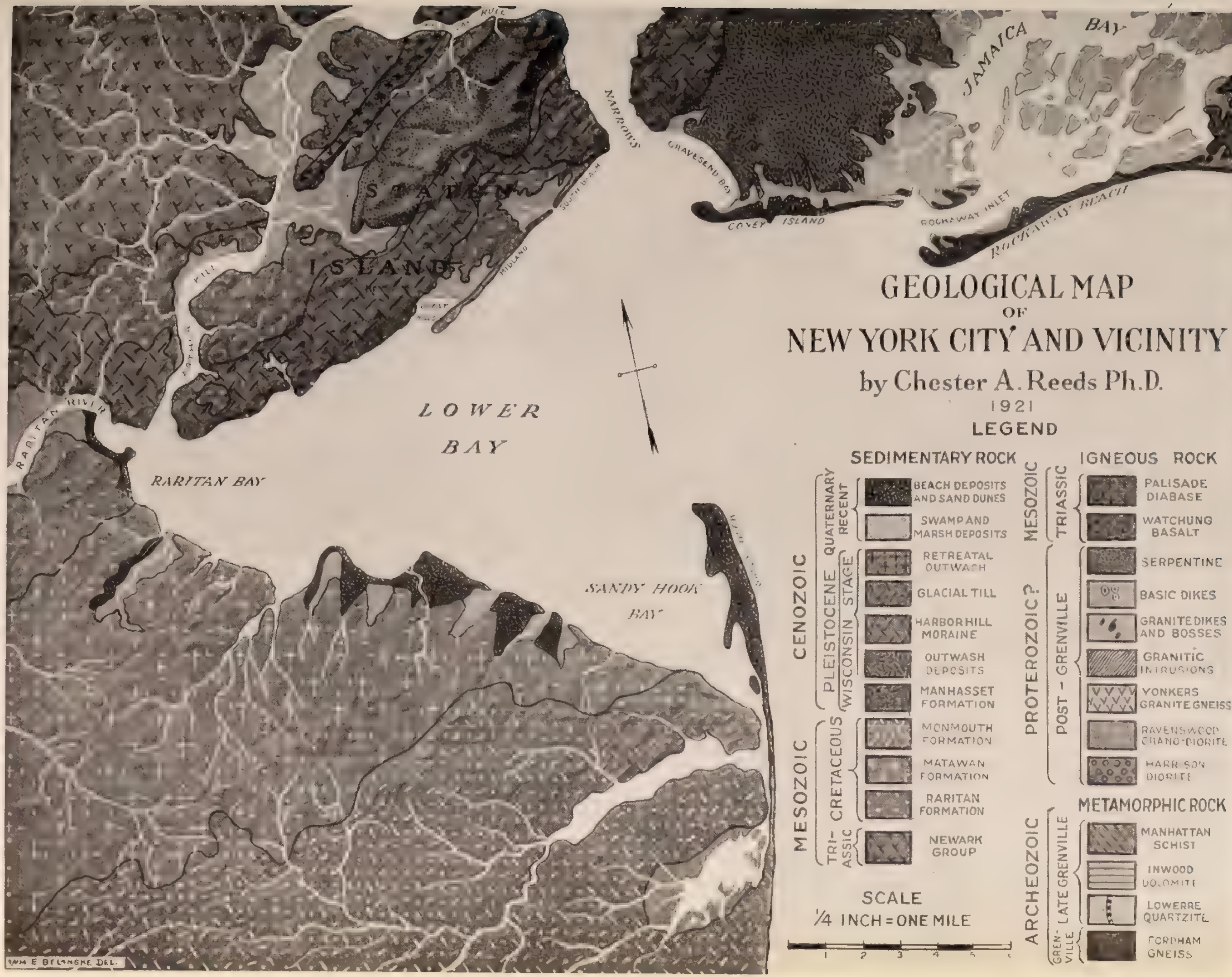
on some of the larger outwash plains are Plainfield, New Jersey; Flatbush and Hempstead, Long Island.

While glacial streams were depositing fan-shaped outwash deposits in many places along the ice front, a glacial lake, Lake Passaic, appeared to the south of the terminal moraine between the crescentic outline of the Watchung Mountains on the east and south and the New Jersey highlands on the west. The waters of the lake drained through the Muggy Hollow outlet at the southwest corner into the Raritan River valley. When the ice front retreated northward, the lake waters followed it and occupied the entire basin behind the Watchung Mountains to the west and southwest of Paterson, New Jersey. The numerous fresh-water marshes of today, along the upper course of the Passaic River, cover portions of the bed of this former glacial lake.

Great accumulations of glacial till, a mechanical mixture consisting of unsorted clay, sand, pebbles, and small bowlders, are found generally in the wake of the glacier. In the New York City district it varies from a fraction of a foot to 500 feet in thickness. A good exposure of it resting on Serpentine rock may be seen at Castle Point, Hoboken, New Jersey, p. 434. It oftentimes fills the pre-glacial stream valleys and frequently covers the leeward side of hills and the lower areas. Test holes in the Harlem River at High Bridge show that the channel has been filled up from 80 to 111 feet by glacial drift and river mud.

The glacial drifts and sediments in the Hudson River gorge at Storm King Mountain have been found by drilling operations to be between 768 and 995 feet thick, with an average of 800 feet. In the vicinity of the Pennsylvania Railroad tunnels at 32nd Street, New York City, the sediments are 300 feet thick, with a possible greater depth in an untested section in midstream. In the Lower Bay deposits accumulated to such an extent that the mouth of the river was almost closed to large ships. Some $4,000,000 have been spent by army engineers in dredging the Ambrose Channel 2000 feet wide by 40 feet deep,


NEW JERSEY
HUDSON
RIVER
LONG ISLAND SOUND
EAST RIVER
HACKENSACK RIVER
MANHATTAN ISLAND
PASSAIC
NEWARK
NEWARK BAY
UPPER BAY
GOVERNORS I.
BROOKLYN
LONG ISLAND


GEOLOGICAL MAP
OF
NEW YORK CITY AND VICINITY
by Chester A. Reeds Ph.D.
1921
LEGEND
SEDIMENTARY ROCK
CENOZOIC
QUATERNARY RECENT
BEACH DEPOSITS AND SAND DUNES
SWAMP AND MARSH DEPOSITS
PLEISTOCENE WISCONSIN STAGE
RETREATAL OUTWASH
GLACIAL TILL
HARBOR HILL MORAINE
OUTWASH DEPOSITS
MANHASSET FORMATION
MESOZOIC
CRETACEOUS
MONMOUTH FORMATION
MATAWAN FORMATION
RARITAN FORMATION
TRI-ASSIC
NEWARK GROUP
SCALE
1/4 INCH = ONE MILE
1 2 3 4 5
IGNEOUS ROCK
MESOZOIC
TRIASSIC
PALISADE DIABASE
WATCHUNG BASALT
PROTEROZOIC?
POST - GRENVILLE
SERPENTINE
BASIC DIKES
GRANITE DIKES AND BOSSES
GRANITIC INTRUSIONS
YONKERS GRANITE GNEISS
RAVENSWOOD GRANO-DIORITE
HARRISON DIORITE
METAMORPHIC ROCK
ARCHEOZOIC
LATE GRENVILLE
MANHATTAN SCHIST
INWOOD DOLOMITE
LOWERRE QUARTZITE
GREN-VILLE
FORDHAM GNEISS
JAMAICA BAY
NARROWS
GRAVESEND BAY
CONEY ISLAND
ROCKAWAY INLET
ROCKAWAY BEACH
STATEN ISLAND
MIDLAND
LOWER BAY
RARITAN BAY
RARITAN RIVER
SANDY HOOK BAY
WM E BELANSKE DEL.

so that the large ocean liners and other vessels may enter the harbor. From a point ten miles out from Sandy Hook to the edge of the continental shelf about one hundred miles distant, a well-defined river channel exists which increases in depth seaward. Near the brink of the continental platform it is 4800 feet deep. Glacial deposits appear over a portion of the course.

Recent Shore Deposits: Sandy Hook, Coney Island, and Rockaway Beach are pronounced coastal irregularities. South Beach and Midland Beach, Staten Island, are less so. These features are temporary for they represent initial stages in the process of coastal simplification. After the initial reefs and barriers have become land, the lagoons behind them are likely to be filled with sediment and organic matter, forming land.

The development of curved spits and beaches along the New Jersey and Long Island shores is worthy of consideration. In the vicinity of Long Branch, New Jersey, the sea cliff indicates wave erosion. The eroded débris is shifted northward by the waves and currents and piled up along the beach which terminates in Sandy Hook. The tendency of the hook to turn westward is due largely to the strong westward sweep of the winds and tides of the Atlantic Ocean. This has been going on for some time, for Sandy Hook is a compound, recurved spit. Rockaway Beach is also compound in appearance while Coney Island is simple. The same forces which drift the sediments north along the New Jersey shore are moving them westward along the Long Island coast in the vicinity of Rockaway and Coney Island. As Staten Island lies across the path of these waves, South Beach and Midland Beach represent a barrier or bar which has been built up by the waves near the line of breakers. That the prevailing direction of currents along the Midland Beach is to the southwest is indicated by the development of a spit in the vicinity of Great Kills. Beach deposition and straightening of the coast line is also in progress on the south shore of the Lower Bay in the vicinity of Port Monmouth, New Jersey.

The estuaries and lagoons east of Port Monmouth are being filled with sediments derived from the land and the growth of vegetation, for, being in the lee of Sandy Hook and the barrier beaches, they are protected from strong sea waves. This is also true of Jamaica Bay, the Flushing Creek basin, Hackensack Meadows, Newark Bay, and the upper reaches of Arthur Kill. These bays and estuaries are the result of recent subsidence of the area. Thus the drowned lands, which now represent shallow sea floors, have been a factor in the placing and development of certain pronounced hooks and barrier beaches. The wind has also notably modified the deposits made by the waves and currents, for it has developed long ridges and sand dunes on the surface of the beaches.

In addition to the shore deposits which are of recent development there are rocks exposed in the New York district which have greater age and a more profound history. There are at least five series of them. While they are in close juxtaposition and have a well-established relation to each other, they are widely separated in origin by great intervals of time. Each series has had its normal period of development; the oldest, however, has suffered greater physical and chemical changes imposed upon it by mountain-making movements and other deformations which have affected it during the growth of the North American continent.

In passing from a consideration of the present shore developments to the oldest series of rocks exposed in the area we go rapidly backward from the Age of Man through the Age of Mammals, the Age of Reptiles, the Age of Amphibians, the Age of Fishes, the Age of Invertebrates, to the little-known but inferred Age of Unicellular Organisms. We shall not take the opportunity to note the

ever-changing shore line, the configuration of the lands and seas, and the great accumulation of sediments which have taken place slowly and repeatedly during these ages. We shall have to omit a discussion of the birth, rise, decay, and disappearance of mountain ranges which have succeeded one another in this and other parts of the continent. Standing on the threshold of the better known eras of geologic time, beginning with the Archæozoic, and turning our back on the hypothetical æons through which the earth must have already passed, let us approach the Present from the chronological point of view.

THE ARCHÆOZOIC ERA: In the dawn of life a series of limestones and associated sedimentary rocks were laid down in Canada near Ottawa, which have been called the Grenville series. According to Professor Berkey, of Columbia University, certain metamorphosed rocks in the Manhattan and Reading prongs of the New England upland are contemporaneous in age. The Fordham gneiss exposed in the Bronx and Westchester counties and northward has all the physical characters of the Grenville series. It consists primarily of granitic and quartzose black and white banded gneisses and schists of very complex composition and structure. Interbedded quartzite and limestones and old igneous intrusions are also included. Note the position on the accompanying geologic map, pp. 436-437.

Overlying the gneiss series in a conformable manner at certain localities is the Lowerre quartzite named after the locality in South Yonkers from which it was first described. It is a thin, schistose quartzite which varies in thickness from a fraction of a foot to 100 feet and rarely out-crops.

This formation is followed by a coarsely crystalline limestone locally tremolitic, micaceous, and pegmatitic, which varies in thickness from 200 to 800 feet. It is called the Inwood dolomite after the Inwood section of the city at the north end of Manhattan Island. Good exposures of the Inwood dolomite occur in the valley north of Dyckman Street, for instance at Marble Hill station on the New York Central Railroad.

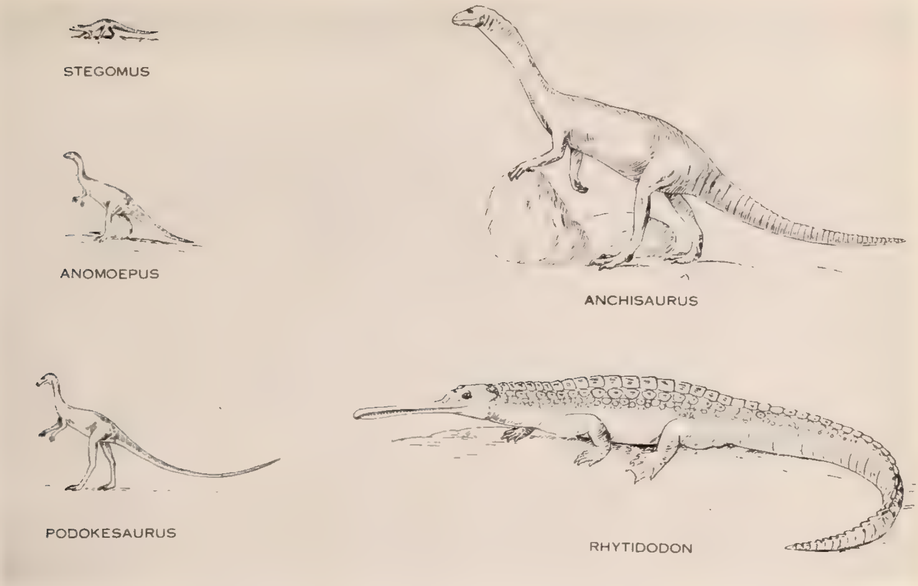
Conformable and overlying the Inwood formation is a coarsely crystalline mica schist, very thick, and pegmatitic, which is called the Manhattan after the extensive exposures on Manhattan Island. The Lowerre-Inwood-Manhattan series is regarded as late Grenville in age. This and the Fordham series constitute the originally sedimentary beds of the Archæozoic Era exposed in the New York City district.

THE PROTEROZOIC ERA, IGNEOUS ROCKS: All igneous rocks of the crystalline area under consideration are younger than the sedimentary members since they have been intruded. But they are not all of the same age or kind. There are granitic stringers and sills which may date back to the close of the earliest of these sedimentary periods, since they partake of all the metamorphic changes that characterize these ancient strata including recrystallization and flowage. The most striking examples are the Yonkers granite gneiss, a sill, and the Ravenswood granodiorite, a boss. Some of the pegmatite streaks and basic intrusions belong to a period of more extensive metamorphic activity and penetrate the Inwood dolomite and Manhattan schist. Examples are the Harrison diorite, basic dikes, granitic dikes, bosses, and intrusions as shown on the accompanying geologic map, pp. 436-437. Serpentine, which is a metamorphic alteration product, has a like origin and distribution.

The entire basal series of rocks have been folded, crumpled, faulted, crushed, injected, intruded, and intensely modified by recrystallization, nevertheless, they retain the fundamental association and essential character of an originally sedimentary series. Many of the gneisses, a few of the schists, all of the granites

Slab showing passage of two Triassic dinosaurs after a shower. The raindrop impressions are represented by small pits. After R. S. Lull

Impressions of the feet and tail of a Triassic dinosaur on a ripple-marked surface. Specimen from Pleasantdale, New Jersey



Certain types of dinosaurs of Triassic age which inhabited the New York, Virginia, and Connecticut valley basins

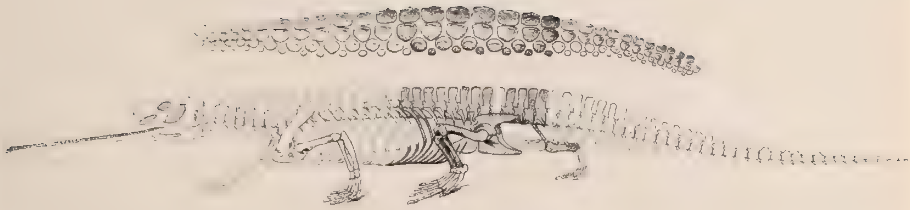
and diorites are of igneous origin and occur as sills, dikes, or bosses, cutting the metamorphosed sedimentary members. They, too, have been greatly metamorphosed and are very ancient, perhaps late Archæozoic or Proterozoic.

THE PALÆOZOIC ERA: The Palæozoic rocks and fossils, which represent a tremendously long period of time and follow the Proterozoic Era, are not found in the immediate vicinity of New York City. They appear, however, in great force in western New Jersey, New York, Pennsylvania, and the Mississippi valley states.

THE MESOZOIC ERA, TRIASSIC PERIOD: From the Hudson River westward to the crystalline rocks of the New Jersey highlands occur a thick series of reddish brown sandstones, shales, and conglomerates, called the Newark group, which dip 10 to 15 degrees to the northwest. Near Philadelphia, Trenton, and New Brunswick, the Stockton, Locatong, and Brunswick formations have been differentiated, but not beneath the glacial drift cover to the northeastward. These sedimentary rocks were deposited in a trough or graben with faulted margins which extended southwestward from the Hudson River across central New Jersey, Pennsylvania, and Maryland into southern Virginia. In all probability a major stream with lateral tributaries occupied the depression. The region was presumably high and arid. Ripple marks, mud cracks, rain drop impressions, and footprints of reptiles are common, especially in the Brunswick shale, and indicate flood plain and shallow water deposition. Restorations of the dinosaurs, *Stegomus*, *Anomoepus*. *Podokesaurus*, *Anchisaurus*, and *Rutiodon* (*Rhytidodon*), which inhabited this zone and the Connecticut Valley, are shown in accompanying illustrations, pp. 441-42-43. Only one skeleton, the Fort Lee *Rutiodon*, pp. 442-43, has been found near New York City. Fossil fishes and a small crustacean, *Estheria ovata*, have also been found. The fossil remains indicate Triassic age. the initial period of the Mesozoic Era, sometimes called the Age of Reptiles.

Three successive lava flows which were extruded during the deposition of the

Fort Lee phytosaur, *Rutiodon manhattanensis.* Photograph of the skeleton as preserved in the original matrix. About $^1/_{10}$ natural size. A description of it was published by the American Museum of Natural History, *Bulletin XXXII*, pp. 275-82, 1913



Restoration of the skeleton and dermal plates of *Rutiodon manhattanensis*. The shaded portion represents the parts preserved in the Fort Lee specimen. After W. D. Matthew

Men excavating the skeleton of the Fort Lee phytosaur on the right bank of the Hudson River, opposite New York City. The specimen was found about twenty feet below the thick sheet of diabase of the Palisades in a red sandy marl

Newark beds have been subsequently faulted, flexed, and tilted into their present position. Since that event erosion has removed a great thickness of the sedimentary rocks and the upturned edges of the lava sheets are now exposed. The First and Second Watchung Mountains and Hook Mountain represent these three basaltic flows. The lowest, First Mountain, is about 600 feet thick, Second Mountain 800 feet, and Hook Mountain 300 feet. About 600 feet of red sandstone and shale separate the first and second, and 1500 feet the second and third. Red Triassic sandstone and shale are also found above and below these volcanic rocks.

The Palisade diabase is a great sheet of igneous rock, from 350 to 1000 feet thick, which was intruded among the lower strata of the Newark group. It extends from Staten Island northward along the west bank of the Hudson River to Haverstraw. At its southern exposed extremity it is practically at sea level, while at the north it is 700 feet higher. Throughout most of its extent it presents an escarpment of high cliffs with vertical columns of rock which were developed during the cooling stage and which suggest the name Palisades.

Cretaceous Period: Stratified rocks which represent the closing stage of the Age of Reptiles rest unconformably upon the Newark group in New Jersey and upon the crystalline basal complex in Staten Island and Long Island. Except for a few exposures along the north coast and the interior of Long Island the Cretaceous sediments are hidden by glacial deposits of Pleistocene age. Their presence, however, is ascertained from numerous deep-well records. In the unglaciated area south of Raritan Bay they are exposed over extensive areas. Here three well-defined members appear, the basal Raritan formation of plastic clays, the Mattawan formation of clay marls, and the Monmouth, including the Rancocas and Mansquan formations of green sand and marls. Fossil marine invertebrates and plant remains indicating Upper Cretaceous age are found in some of these beds. The Cretaceous deposits of Long Island, which average 1550 feet in thickness, vary greatly in composition within short distances and are, on the whole, more sandy than those of New Jersey. An exposure may be seen at Elm Point on Great Neck, Long Island.

The inclination to the southeast of the bed rock surface on which these sediments were deposited is about 40 feet to the mile in New Jersey, 80 feet near Oyster Bay and Huntington, and 40 feet at Port Jefferson, Long Island. The dip of the beds, which is the same as the slope of the unexposed floor, probably decreases toward the east and south. This old Cretaceous floor is still preserved inland in the crests of the Palisade and Watchung ridges, Schooley Mountain and Kittatinny Mountain of New Jersey and in the truncated folds of the Appalachian Mountains west of Harrisburg, Pennsylvania. Locally in Long Island the weak upper beds of the Cretaceous series have been greatly folded and contorted by the passage of the Pleistocene glaciers over them.

The Cenozoic Era, Pleistocene Events: Four glacial and three interglacial stages are represented on Long Island. The periods of glaciation correspond to the Nebraskan, Kansan, Illinoian, and Wisconsin of the Central United States, and to the Günz, Mindel, Riss, and Würm of the Alps Mountains. Locally they have been named by Mr. M. L. Fuller, of the United States Geological Survey, the Mannetto, Jameco, Manhasset, and Wisconsin stages and are represented primarily by gravel and morainal deposits. The only ones represented within the limits of the accompanying geological map are the Manhasset and Wisconsin. The outwash, terminal moraine, till, and retreatal outwash deposits of the Wisconsin stage are far more extensive and readily examined than the similar accumulations of the older stages since they were the

last and cover in large part those made during the preceding glaciations.

The First Interglacial stage, the post-Mannetto, was long, for a great erosion unconformity exists. Following the deposition of the Mannetto gravel of the First Glaciation, there was a period of uplift and erosion in which the Mannetto was cut to a depth of 300 feet below sea level, as shown by the depth of the buried Jameco channel in Long Island. The great length of this period of erosion, indicated by the almost complete removal of the thick Mannetto gravel from the Long Island region, is in harmony with the time required for the cutting of the Hudson River rock gorge to a depth of 750 feet below present sea level. The gorge proper appears to be filled solely with Pleistocene materials as indicated by the Storm King and other borings; hence, its cutting is to be referred to a date later than the deposition of the latest Tertiary beds in New Jersey.

The narrow, steep-sided and deep outer cañon of the submarine channel, if due to stream erosion, must be referred to an elevation of great magnitude, 4800 feet, occurring at the close of the post-Mannetto erosion stage. The great drops or falls in its beds are characteristic of a juvenile stream or old one which has been rejuvenated. As only the edge of the continental shelf was notched, the epoch of maximum elevation must have been brief.

During the Second Interglacial stage, the Yarmouth of the Mississippi Valley, the Gardiners clay was deposited in Long Island. It was followed by a transitional epoch represented by the Jacob sand. Throughout the time of the Second Glaciation, the Second Interglacial, and the Third Glaciation, the channel of the Hudson remained constantly below sea level. The deposits, which have a combined thickness of about 500 feet, doubtless obliterated the upper reaches of the submarine Hudson channel.

The Third Interglacial interval, the Vineyard, is represented by (a) a great erosion unconformity, and (b) the Vineyard formation, consisting of marine deposits and peat. The valleys in the Manhasset deposits, although somewhat modified and partly filled with the later Wisconsin accumulations, are known to extend some distance below sea level at many points along the north shore, indicating a former higher position of the land. The present upper submarine channel of the Hudson, which has a depth at its outer end of 350 feet, suggests that the land must have been elevated to that extent during the Vineyard interval.

There are no erosion channels referable to Wisconsin or post-Wisconsin elevation on Long Island. The upper end of the Hudson channel, however, between Sandy Hook and Rockaway Beach, has been obliterated in part by Wisconsin outwash and in part by the shifting of the sands by the littoral currents that now sweep along the coast.

Thus in this rapid survey we have considered very briefly the Archæozoic, Proterozoic, Palæozoic, Mesozoic, (Triassic, Cretaceous), and Cenozoic (Pleistocene) series of rocks as represented in New York City and its vicinity. They are replete with interest but they represent only a few isolated and incomplete chapters of the geologic history of North America. The long Palæozoic era, including the Age of Invertebrates, Age of Fishes, and Age of Amphibians, is not represented by sediments in the area of the geologic map, pp. 436-37. The Jurassic and Lower Cretaceous periods occupying the middle portion of the Mesozoic era, the Age of Reptiles, are also not represented in this district. Likewise the Tertiary series, corresponding to the Age of Mammals, appears ~~outside the area~~. The Pleistocene glacial deposits, which are contemporaneous with the Age of Man, are rather fully represented but, as yet, no human remains have been found in them in this area or anywhere in North America.

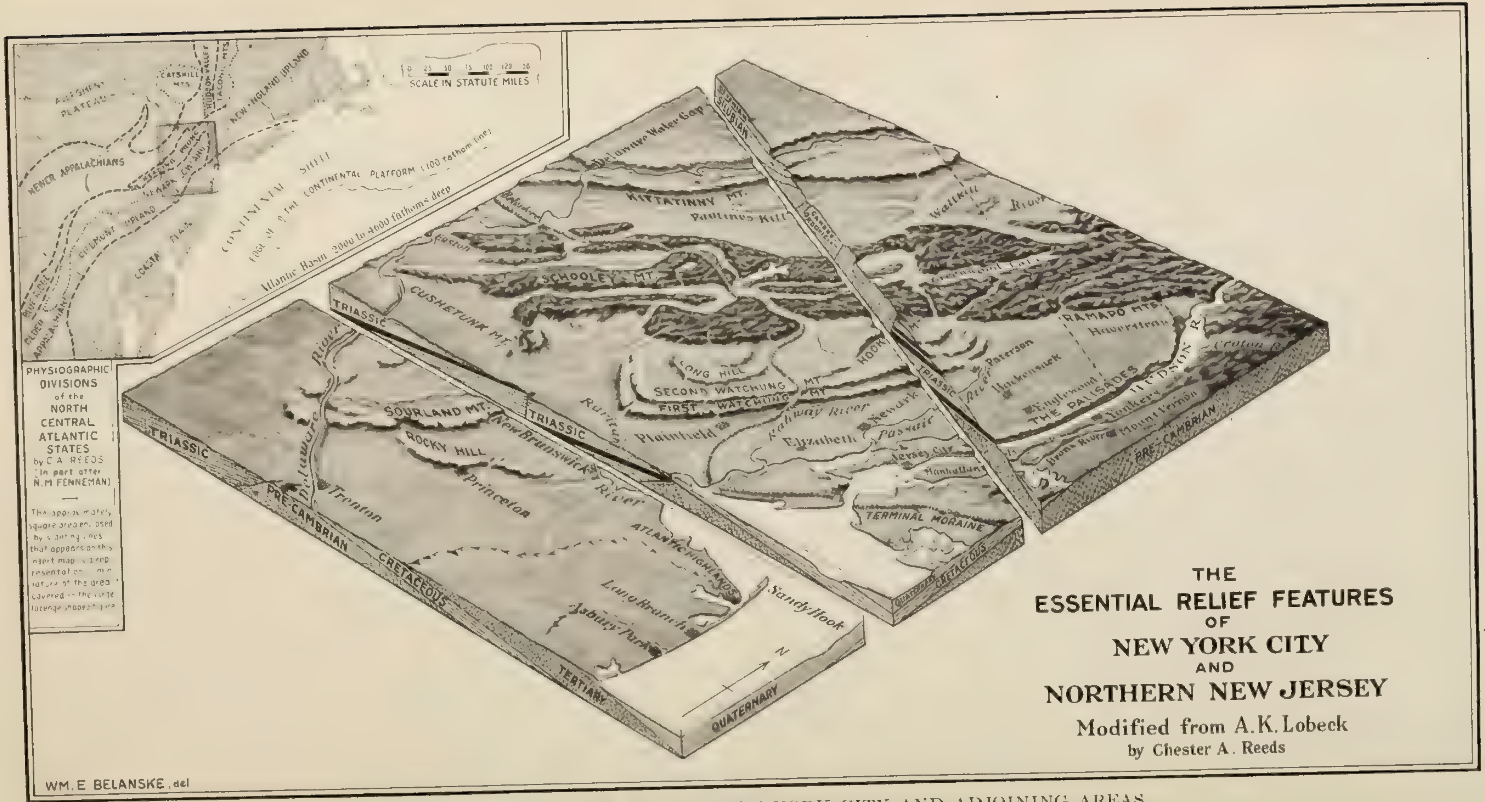
THE AMERICAN MUSEUM OF NATURAL HISTORY

THE GEOLOGY OF NEW YORK CITY AND VICINITY

MANHATTAN SCHIST

By CHESTER A. REEDS

GUIDE LEAFLET SERIES No. 56



DIAGRAMMATIC RELIEF MAP OF NEW YORK CITY AND ADJOINING AREAS

GEOLOGY OF NEW YORK CITY AND ITS VICINITY

By CHESTER A. REEDS
Associate Curator of Invertebrate Palæontology

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Geology of New York City and Its Vicinity

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THE relief features of the New York City district consist of several distinctly different types, which have been developed by natural forces on rocks of unequal hardness. Some of the rocks are unconsolidated sands and muds and are of comparatively recent date; others are stratified with alternating hard and soft beds, which have been tilted or slightly folded and are older; still others of the same origin but far older have been so much altered and deformed during certain geologic periods that they have become crystalline and entirely changed in appearance, that is, metamorphosed. Volcanic rocks thick and homogeneous in character have also been injected into the area at different times, some very early, others later, but none very recently. These and some of the crystalline ones form the most resistant ridges. The distribution of the rocks is in the form of belts with a prevailing northeast-southwest direction.

The essential relief features and physiographic provinces of the area are shown in a graphic manner on the relief map, *frontispiece*. They may be summarized as follows:

1. The continental shelf, which represents the submerged margin of the continent, extends eastward from the New Jersey shore for about 100 miles to the 100 fathom line. Beyond that point the sea floor drops rapidly to the great and extensive oceanic depths of 2000–4600 fathoms.

2. The Coastal Plain is that portion of the former submerged continental shelf which has been raised above the sea without apparent deformation. Three well defined elements of this plain appear:

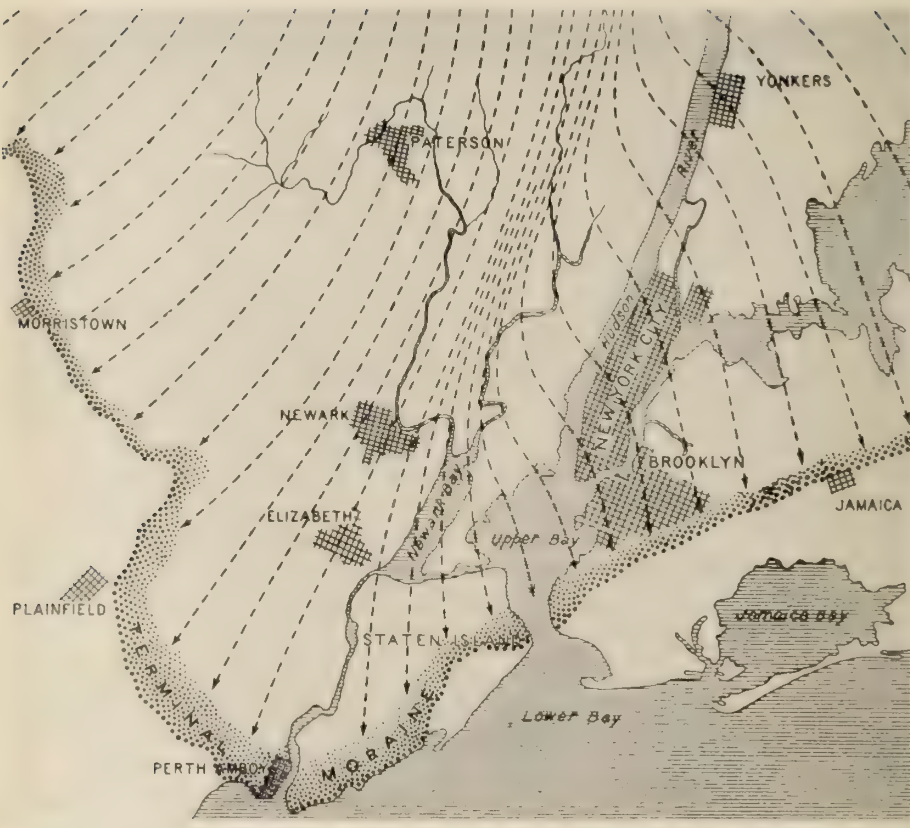
(a) Its inner lowland, partly drowned in Long Island Sound, Lower New York and Sandy Hook bays, extends southwestward along the main railway lines through New Brunswick, Trenton, Philadelphia, Baltimore, and Washington;

(b) Its fall line features appear on the Delaware at Trenton, on the Schuylkill at Philadelphia, on the Potomac at the Great Falls above Washington, D. C., and on the James River at Richmond:

(c) Its cuesta forms the foundation of Long Island, the Atlantic Highlands, and the ragged front making up the hilly belt of southern New Jersey.

3. The Newark Lowland is a plain developed on inclined weak strata consisting of red sandstones and shales of Triassic age. The intrusive sheets of resistant volcanic rock form the prominent residual ridges known as the Palisades, Watchung, Hook, Cushetunk and Sourland mountains, and Long and Rocky hills.

4. The New England Upland is represented in the district by the Manhattan and Reading prongs. This upland consists of dissected and disordered crystalline rocks. The Manhattan prong extends down the east bank of the Hudson estuary from the Highlands to and including Manhattan Island. The north central portion of Staten Island is an outlier. The Reading prong extends as highlands from the gorge of the Hudson southwestward across New York and New Jersey to Reading, Pennsylvania.



Sketch map of New York City and vicinity, showing position of the terminal moraine and directions of the ice movement (indicated by the arrows) during the last or Wisconsin glaciation. After United States Geological Survey

5. The broad valley to the west occupied by the Wallkill and Paulins Kill is a part of the great Appalachian Valley, which extends from Birmingham, Alabama, to Lake Champlain. It is one of the prominent subdivisions of the Newer Appalachian physiographic province.

6. The narrow Kittatinny Mountain ridge dipping westward, represents the northeastern extension of the belt of newer and folded Appalachians of central Pennsylvania.

7. The Alleghany Plateau appears west of the Delaware River. Farther north in New York State the Catskill Mountains represent a subdivision of this plateau.

Glaciation: The northern portion of the New York City district has been traversed at least four times by great sheets of ice which moved down from the Labrador center. These continental glaciers modified the drainage and the surface of the land over which they passed. The terminal moraine which represents the southernmost extent of the last ice field appears as a conspicuous ridge consisting of knobs and kettle holes on Long Island, Staten Island, and New Jersey. It continues westward across the United States to the Pacific Ocean near Seattle, Washington.

The drift bowlders and unsorted rock débris in the terminal moraine and

The "rocking stone," New York Zoölogical Park, an ice-transported bowlder resting on a glaciated surface

northward give a clue as to the direction of ice movement. Large bowlders of crystalline rock from Jamaica and Hollis, Long Island, indicate that they were plucked out of the bed rock in the vicinity of Yonkers, Mt. Vernon, and other places in Westchester County, New York. Glacial-borne pebbles containing fossils and oolites have been found at Broadway and 191st Street. The fossils represent minute fragments of bryozoa and corals, of Devonian age, which are similar to those found at present in the Catskill Mountain region. The oolites, which are small, concentric spheres cemented together, resemble fish roe. They, too, came from up-state New York. On Staten Island, Long Island, and Short Hills, New Jersey, many large drift bowlders of sedimentary origin and containing numerous marine fossils were derived from the exposures in east central New York State.

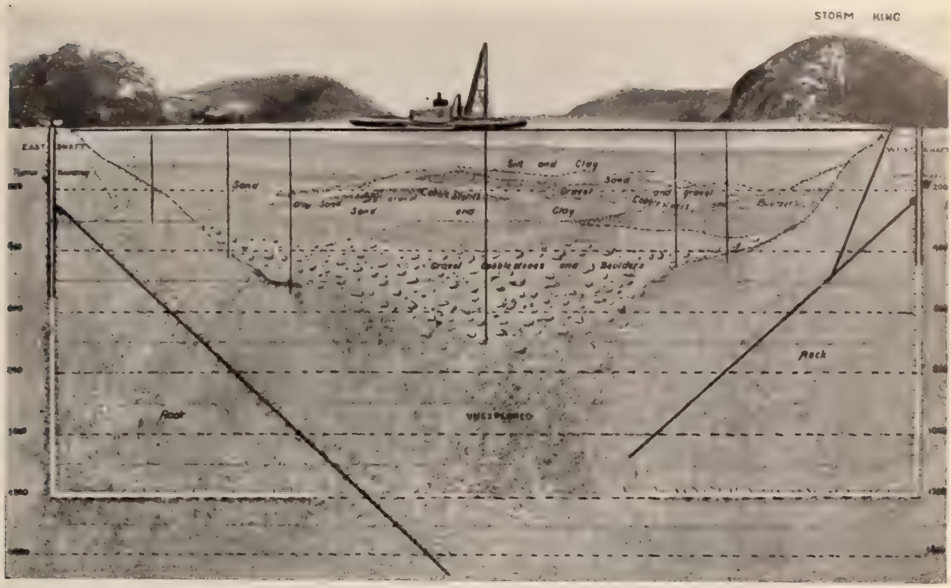
Each of the four continental glaciers of the Pleistocene epoch consisted of ice thousands of feet thick. They not only plucked out huge bowlders the size of a house and transported them long distances, but they also scoured off the soil-cover in many places and left bare rock surfaces, *roches moutonnées*, little deserts in fact, on which no plants other than lichens can grow. A good example of a glaciated surface with an ice-transported bowlder resting upon it is the "rocking stone" in the New York Zoölogical Park, Bronx, figured above.

Rocks held firmly in the base of the ice served not only as abrasives but also

Exposure of glacial till, containing sand, gravel, and bowlders, in contact with Serpentine rock, at Castle Point, Hoboken. After United States Geological Survey, Passaic Folio, No. 157

as etching tools. Deep parallel grooves in crystalline rock appear at various places on Riverside Drive, particularly on the south side of the Drive where it leaves the Hudson River at about 200th Street. These glacial striæ running northwest-southeast give the direction of ice movement. Many diabase bowlders from the Palisades found in Yonkers and New York City indicate that the ice moved southeasterly, diagonally across the Palisades and the Hudson River, as shown on the diagram, p. 2.

A stream leaving the front of the glacier oftentimes contained a large



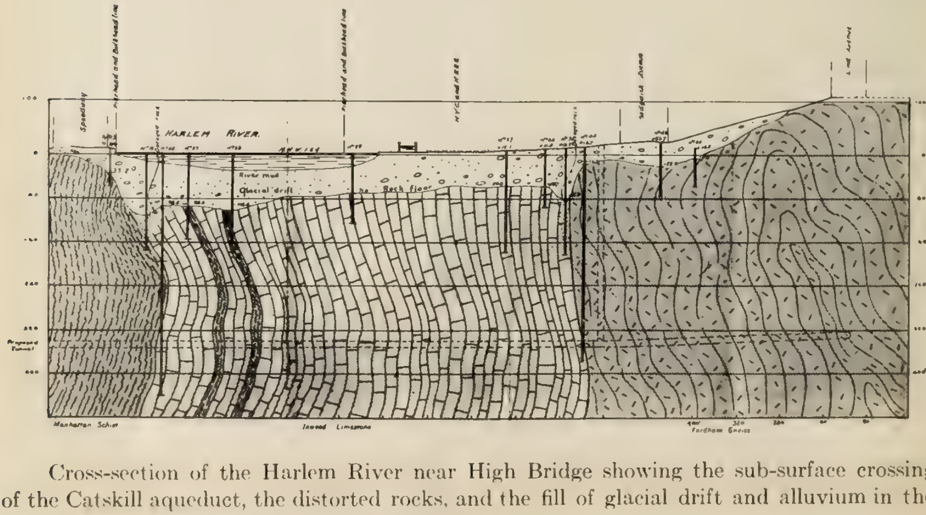
Cross-section drawing of the sediments in the Hudson River at Storm King Mountain, where is located the great siphon of the New York City aqueduct. From *Bulletin* 146 of the New York State Museum

volume of water and had considerable transporting power. Hence pebbles, sand, and fine rock débris were carried in considerable quantity. In most instances the streams deployed fanwise almost immediately on their emergence from the glacial sheet and the material carried from the ice was dropped close to the margin of the glacier. The fans formed by single streams were usually small, being from half a mile to two miles in radius; confluent fans were larger, varying from one to six miles in radius. The materials are somewhat sorted and stratified and are called outwash deposits. These deposits occur at short intervals along the southern margin of the terminal moraine. Towns built on some of the larger outwash plains are Plainfield, New Jersey, Flatbush and Hempstead, Long Island.

While glacial streams were depositing fan-shaped outwash deposits in many places along the ice front, a glacial lake, Lake Passaic, appeared to the south of the terminal moraine between the crescentic outline of the Watchung Mountains on the east and south and the New Jersey highlands on the west. The waters of the lake drained through the Muggy Hollow outlet at the southwest corner into the Raritan River valley. When the ice front retreated northward, the lake waters followed it and occupied the entire basin behind the Watchung Mountains to the west and southwest of Paterson, New Jersey. The numerous fresh-water marshes of today, along the upper course of the Passaic River, cover portions of the bed of this former glacial lake. See map, pp. 12-13.

Great accumulations of glacial till, a mechanical mixture consisting of unsorted clay, sand, pebbles, and small bowlders, are found generally in the wake of the glacier. In the New York City district it varies from a fraction of a foot to 500 feet in thickness. A good exposure of it resting on Serpen-

Aeroplane view of Upper Manhattan Island, with the Harlem River in the foreground, the Hudson river and Palisades in the background. The three aqueducts, High Bridge, Croton and Catskill, which supply water to New York City, enter Manhattan at this point.



Cross-section of the Harlem River near High Bridge showing the sub-surface crossing of the Catskill aqueduct, the distorted rocks, and the fill of glacial drift and alluvium in the river bed. From *Bulletin* 146, New York State Museum.

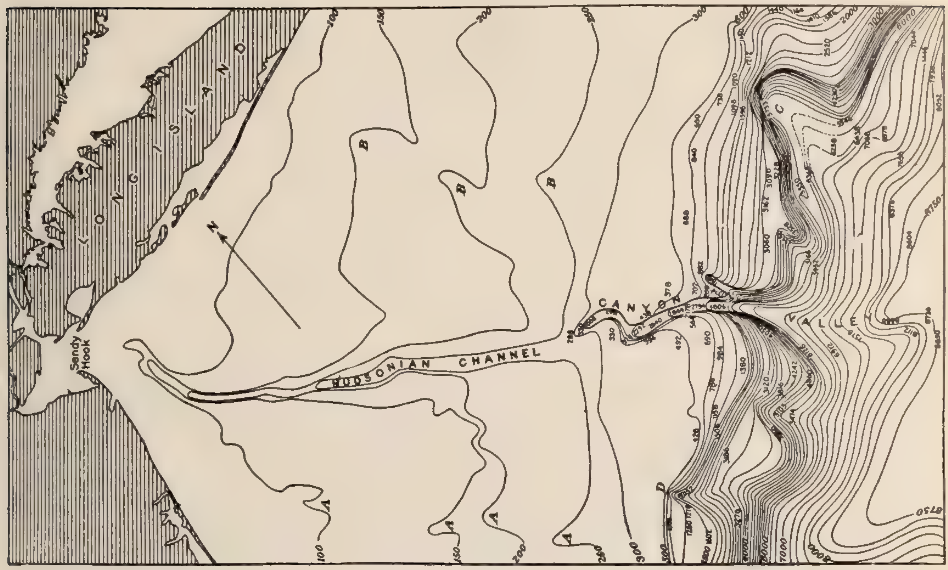


Chart of the outer submarine channel and canyon of the Hudson River. After United States Geological Survey.

tine rock may be seen at Castle Point, Hoboken, New Jersey, p. 4. It oftentimes fills the pre-glacial stream valleys and frequently covers the leeward side of hills and the lower areas. Test holes in the Harlem River at High Bridge show that the channel has been filled up from 80 to 111 feet by glacial drift and river mud, p. 6.

The glacial drifts and sediments in the Hudson River gorge at Storm King Mountain have been found by drilling operations to be between 768 and 995 feet thick, with an average of 800 feet. In the vicinity of the Pennsylvania Railroad tunnels at 32nd Street, New York City, the sediments are 300 feet thick, with a possible greater depth in an untested section in midstream. In the Lower Bay deposits accumulated to such an extent that the mouth of the river was almost closed to large ships. Some $4,000,000 have been spent by army engineers in dredging the Ambrose Channel 2000 feet wide by 40 feet deep, so that the large ocean liners and other vessels may enter the harbor. From a point ten miles out from Sandy Hook to the edge of the continental shelf about one hundred miles distant, a well-defined river channel exists which increases in depth seaward. Near the brink of the continental platform it is 4800 feet deep. Glacial deposits appear over a portion of the course, p. 7.

Recent Shore Deposits: Sandy Hook, Coney Island, and Rockaway Beach are pronounced coastal irregularities. South Beach and Midland Beach, Staten Island, are less so. These features are temporary for they represent initial stages in the process of coastal simplification. After the initial reefs and barriers have become land, the lagoons behind them are like to be filled with sediment and organic matter, forming land. See map, pp. 12-13.

The development of curved spits and beaches along the New Jersey and Long Island shores is worthy of consideration. In the vicinity of Long Branch, New Jersey, the sea cliff indicates wave erosion. The eroded

débris is shifted northward by the waves and currents and piled up along the beach which terminates in Sandy Hook. The tendency of the hook to turn westward is due largely to the strong westward sweep of the winds and tides of the Atlantic Ocean. This has been going on for some time, for Sandy Hook is a compound, recurved spit. Rockaway Beach is also compound in appearance while Coney Island is simple. The same forces which drift the sediments north along the New Jersey shore are moving them westward along the Long Island coast in the vicinity of Rockaway and Coney Island. As Staten Island lies across the path of these waves, South Beach and Midland Beach represent a barrier or bar which has been built up by the waves near the line of breakers. That the prevailing direction of currents along the Midland Beach is to the southwest is indicated by the development of a spit in the vicinity of Great Kills. Beach deposition and straightening of the coast line is also in progress on the south shore of the Lower Bay in the vicinity of Port Monmouth, New Jersey.

The estuaries and lagoons east of Port Monmouth are being filled with sediments derived from the land and the growth of vegetation, for, being in the lee of Sandy Hook and the barrier beaches, they are protected from strong sea waves. This is also true of Jamaica Bay, the Flushing Creek basin, Hackensack Meadows, Newark Bay, and the upper reaches of Arthur Kill. These bays and estuaries are the result of recent subsidence of the area. Thus the drowned lands, which now represent shallow sea floors, have been a factor in the placing and development of certain pronounced hooks and barrier beaches. The wind has also notably modified the deposits made by the waves and currents, for it has developed long ridges and sand dunes on the surface of the beaches.

In addition to the shore deposits which are of recent development there are rocks exposed in the New York district which have greater age and a more profound history. There are at least five series of them. While they are in close juxtaposition and have a well-established relation to each other, they are widely separated in origin by great intervals of time. Each series has had its normal period of development; the oldest, however, has suffered greater physical and chemical changes imposed upon it by mountain-making movements and other deformations which have affected it during the growth of the North American continent.

In passing from a consideration of the present shore developments to the oldest series of rocks exposed in the area we go rapidly backward from the Age of Man through the Age of Mammals, the Age of Reptiles, the Age of Amphibians, the Age of Fishes, the Age of Invertebrates, to the little-known but inferred Age of Unicellular Organisms. We shall not take the opportunity to note the ever-changing shore line, the configuration of the lands and seas, and the great accumulation of sediments which have taken place slowly and repeatedly during these ages. We shall have to omit a discussion of the birth, rise, decay, and disappearance of mountain ranges which have succeeded one another in this and other parts of the continent. Standing on the threshold of the better known eras of geologic time, beginning with the Archæozoic, and turning our back on the hypothetical æons through which the earth must

Ancient contorted Manhattan schist (Archeozoic) with rather recent glaciated surface (Pleistocene). See geologic map. pp. 10–11. South Meadow, Central Park, Manhattan. E. O. Hovey, photo.

have already passed, let us approach the Present from the chronological point of view.

THE ARCHÆOZOIC ERA: In the dawn of life a series of limestones and associated sedimentary rocks were laid down in Canada near Ottawa, which have been called the Grenville series. According to Professor Berkey, of Columbia University, certain metamorphosed rocks in the Manhattan and Reading prongs of the New England upland are contemporaneous in age. The Fordham gneiss exposed in the Bronx and Westchester counties and northward has all the physical characters of the Grenville series. It consists primarily of granitic and quartzose black and white banded gneisses and schists of very complex composition and structure. Interbedded quartzite and limestones and old igenous intrusions are also included. Note the position on the accompanying geologic map, pp. 10–11.

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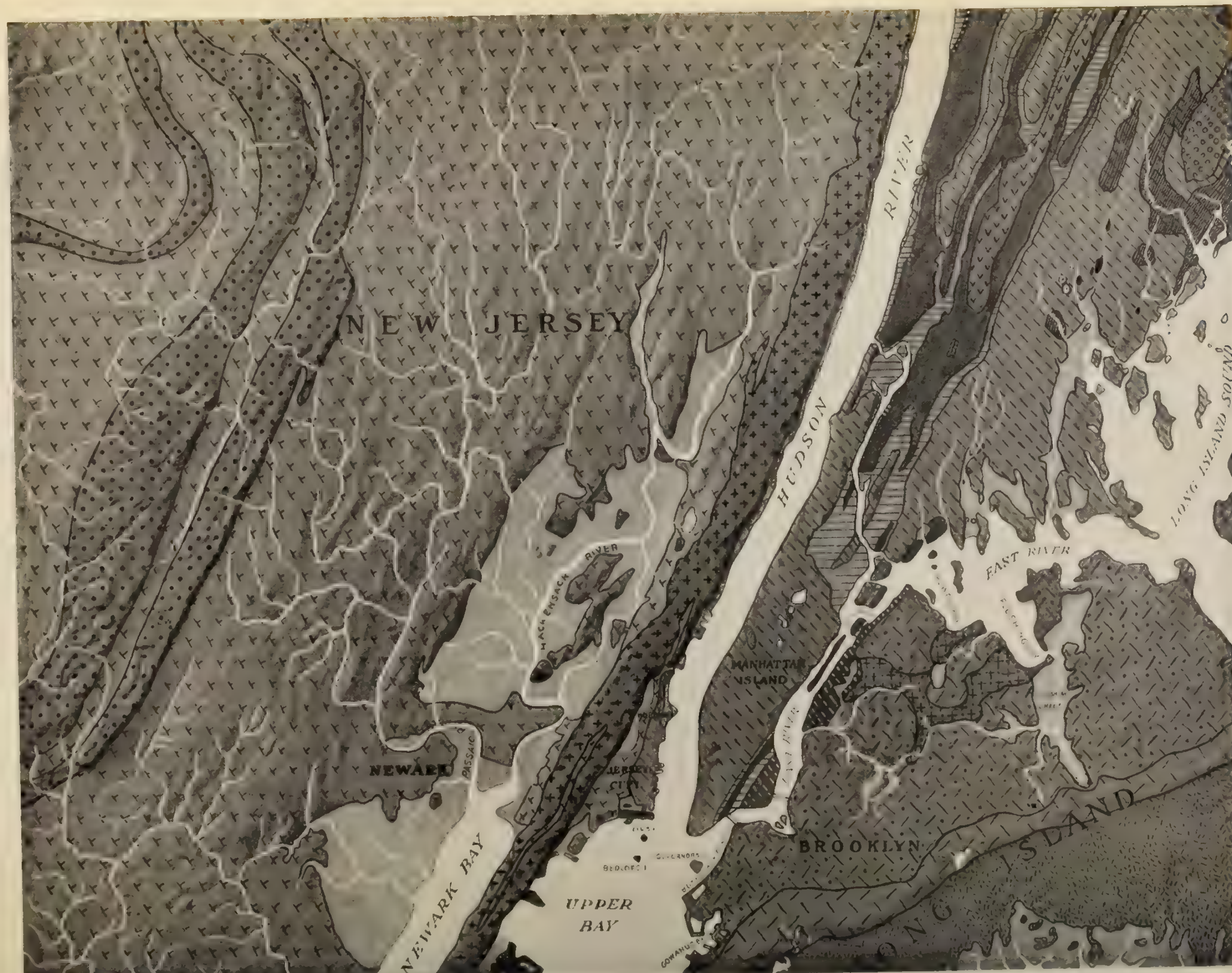
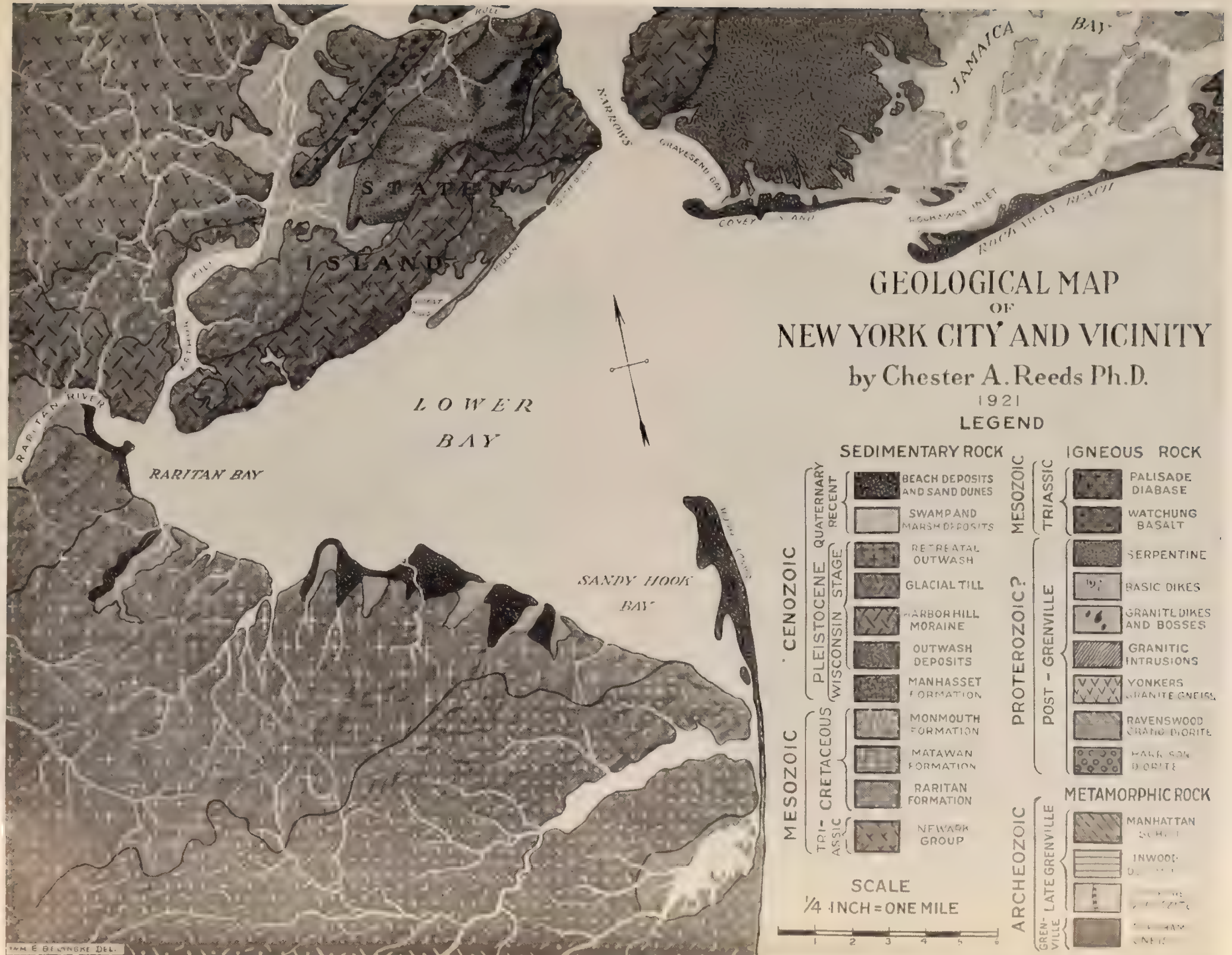
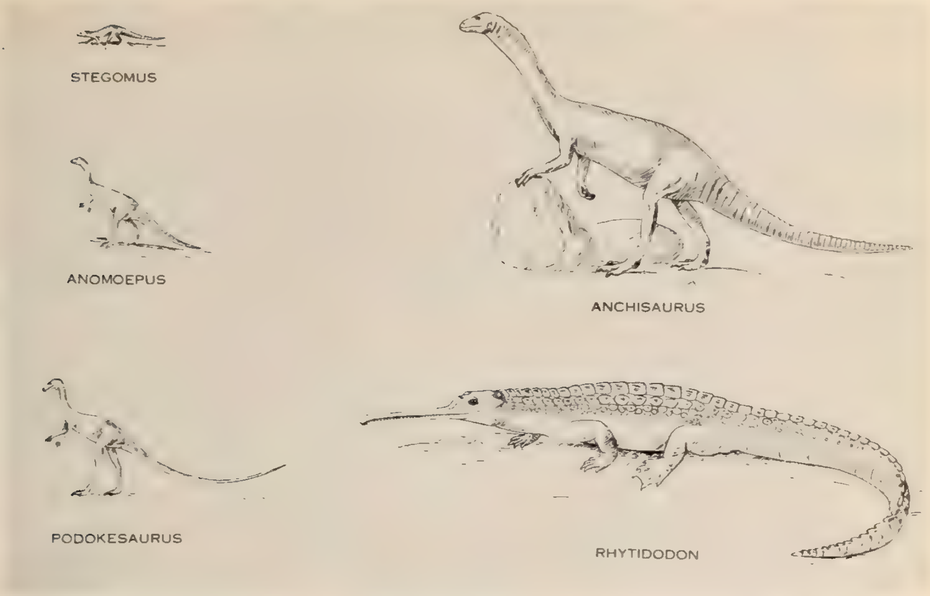

NEW JERSEY
HUDSON
RIVER
LONG ISLAND SOUND
EAST RIVER
HACKENSACK RIVER
MANHATTAN ISLAND
PASSAIC
NEWARK
JERSEY CITY
BROOKLYN
LONG ISLAND
UPPER BAY
NEWARK BAY


GEOLOGICAL MAP
OF
NEW YORK CITY AND VICINITY
by Chester A. Reeds Ph.D.
1921
LEGEND
SEDIMENTARY ROCK
CENOZOIC
QUATERNARY RECENT
BEACH DEPOSITS AND SAND DUNES
SWAMP AND MARSH DEPOSITS
PLEISTOCENE WISCONSIN STAGE
RETREATAL OUTWASH
GLACIAL TILL
HARBOR HILL MORAINE
OUTWASH DEPOSITS
MANHASSET FORMATION
MESOZOIC
CRETACEOUS
MONMOUTH FORMATION
MATAWAN FORMATION
RARITAN FORMATION
TRI-ASSIC
NEWARK GROUP
IGNEOUS ROCK
MESOZOIC
TRIASSIC
PALISADE DIABASE
WATCHUNG BASALT
PROTEROZOIC?
POST - GRENVILLE
SERPENTINE
BASIC DIKES
GRANITE DIKES AND BOSSES
GRANITIC INTRUSIONS
YONKERS GRANITE GNEISS
RAVENSWOOD GRANO DIORITE
METAMORPHIC ROCK
ARCHEOZOIC
LATE GRENVILLE
MANHATTAN
GREN-VILLE
SCALE
1/4 INCH = ONE MILE
1 2 3 4 5 6
STATEN ISLAND
LOWER BAY
RARITAN BAY
RARITAN RIVER
SANDY HOOK BAY
NARROWS
GRAVESEND BAY
JAMAICA BAY
ROCKAWAY INLET
KILL
MIDLAND

Slab showing passage of two Triassic dinosaurs after a shower. The rain drop impressions are represented by small pits. After R. S. Lull

Impressions of the feet and tail of a Triassic dinosaur on a ripple-marked surface. Specimen from Pleasantdale, N. J.



Certain types of dinosaurs of Triassic age which inhabited the New York, Virginia, and Connecticut valley basins

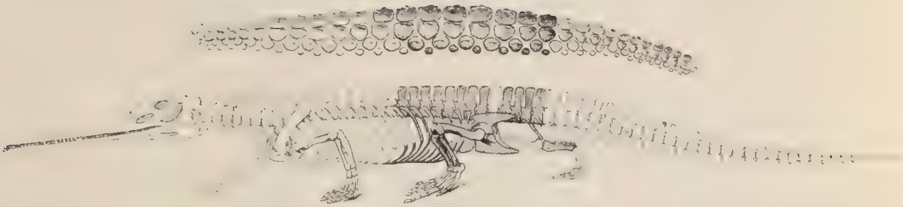
dolomite after the Inwood section of the city at the north end of Manhattan Island. Good exposures of the Inwood dolomite occur in the valley north of Dyckman Street, for instance at Marble Hill station on the New York Central Railroad.

Conformable and overlying the Inwood formation is a coarsely crystalline mica schist, very thick, and pegmatitic, which is called the Manhattan after the extensive exposures on Manhattan Island, p. 9. The Lowerre-Inwood-Manhattan series is regarded as late Grenville in age. This and the Fordham series constitute the originally sedimentary beds of the Archæozoic Era exposed in the New York City district.

The Proterozoic Era, Igneous Rocks: All igneous rocks of the crystalline area under consideration are younger than the sedimentary members since they have been intruded. But they are not all of the same age or kind. There are granitic stringers and sills which may date back to the close of the earliest of these sedimentary periods, since they partake of all the metamorphic changes that characterize these ancient strata including recrystallization and flowage. The most striking examples are the Yonkers granite gneiss, a sill, and the Ravenswood granodiorite, a boss. Some of the pegmatite streaks and basic intrusions belong to a period of more extensive metamorphic activity and penetrate the Inwood dolomite and Manhattan schist. Examples are the Harrison diorite, basic dikes, granitic dikes, bosses, and intrusions as shown on the accompanying geologic map, pp. 10–11. Serpentine, which is a metamorphic alteration product, has a like origin and distribution.

The entire basal series of rocks have been folded, crumpled, faulted, crushed, injected, intruded, and intensely modified by recrystallization, nevertheless, they retain the fundamental association and essential character of an originally

Fort Lee phytosaur, *Rutiodon manhattanensis.* Photograph of the skeleton as preserved in the original matrix. About $\frac{1}{10}$ natural size. A description of it was published by the American Museum of Natural History, *Bulletin* XXXII, pp. 275–82, 1913



Restoration of the skeleton and dermal plates of *Rutiodon manhattanensis*. The shaded portion represents the parts preserved in the Fort Lee specimen. After W. D. Matthew.

Men excavating the skeleton of the Fort Lee phytosaur on the west bank of the Hudson River opposite 155th Street, New York City. The specimen was found in a red sandy marl about twenty feet below the thick sheet of diabase of the Palisades

sedimentary series. Many of the gneisses, a few of the schists, all of the granites and diorites are of igneous origin and occur as sills, dikes, or bosses, cutting the metamorphosed sedimentary members. They, too, have been greatly metamorphosed and are very ancient, perhaps late Archæozoic or Proterozoic.

THE PALÆOZOIC ERA: The Palæozoic rocks and fossils, which represent a tremendously long period of time and follow the Proterozoic Era, are not found in the immediate vicinity of New York City. They appear, however, in great force in western New Jersey, New York, Pennsylvania, and the Mississippi valley states.

THE MESOZOIC ERA, TRIASSIC PEROID: From the Hudson River westward to the crystalline rocks of the New Jersey highlands occur a thick series of reddish brown sandstones, shales, and conglomerates, called the Newark group, which dip 10 to 15 degrees to the northwest. Near Philadelphia, Trenton, and New Brunswick, the Stockton, Locatong, and Brunswick formations have been differentiated, but not beneath the glacial drift cover to the northeastward. These sedimentary rocks were deposited in a trough or graben with faulted margins which extended southwestward from the Hudson River across central New Jersey, Pennsylvania, and Maryland into southern Virginia. In all probability a major stream with lateral tributaries occupied the depression. The region was presumably high and arid. Ripple marks, mud cracks, rain drop impressions, and footprints of reptiles are common, especially in the Brunswick shale, and indicate flood plain and shallow water deposition. Restorations of the dinosaurs, *Stegomus*, *Anomoepus*, *Podokesaurus*, *Anchisaurus*, and *Rutiodon* (*Rhytidodon*), which inhabited this zone and the Connecticut Valley, are shown in accompanying illustrations, pp. 13–14–15. Only one skeleton, the Fort Lee *Rutiodon*, pp. 14–15, has been found near New York City. Fossil fishes and a small crustacean, *Estheria ovata*, have also been found. The fossil remains indicate Triassic age, the initial period of the Mesozoic Era, sometimes called the Age of Reptiles.

Three successive lava flows which were extruded during the deposition of the Newark beds have been subsequently faulted, flexed, and tilted into their present position. Since that event erosion has removed a great thickness of sedimentary rocks and the upturned edges of the lava sheets are now exposed. The First and Second Watchung Mountains and Hook Mountain represent these three basaltic flows. The lowest, First Mountain, is about 600 feet thick, Second Mountain 800 feet, and Hook Mountain 300 feet. About 600 feet of red sandstone and shale separate the first and second, and 1500 feet the second and third. Red Triassic sandstone and shale are also found above and below these volcanic rocks.

The Palisade diabase is a great sheet of igneous rock, from 350 to 1000 feet thick, which was intruded among the lower strata of the Newark group. It extends from Staten Island northward along the west bank of the Hudson River to Haverstraw. At its southern exposed extremity it is practically at sea level, while at the north it is 700 feet higher. Throughout most of its extent it presents an escarpment of high cliffs with vertical columns of rock which were developed during the cooling stage and which suggest the name Palisades, p. 16.

Palisades of the Hudson opposite Spuyten Duyvil, N. Y.

Cretaceous Period: Stratified rocks which represent the closing stage of the Age of Reptiles rest unconformably upon the Newark group in New Jersey and upon the crystalline basal complex in Staten Island and Long Island. Except for a few exposures along the north coast and the interior of Long Island the Cretaceous sediments are hidden by glacial deposits of Pleistocene age. Their presence, however, is ascertained from numerous deep-well records. In the unglaciated area south of Raritan Bay they are exposed over extensive areas. Here three well-defined members appear, the basal Raritan formation of plastic clays, the Mattawan formation of clay marls, and the Monmouth, including the Rancocas and Mansquan formations of green sand and marls. Fossil marine invertebrates and plant remains indicating Upper Cretaceous age are found in some of these beds. The Cretaceous deposits of Long Island, which average 1550 feet in thickness, vary greatly in composition within short distances and are, on the whole, more sandy than those of New Jersey. An exposure may be seen at Elm Point on Great Neck, Long Island.

The inclination to the southeast of the bed rock surface on which these sediments were deposited is about 40 feet to the mile in New Jersey, 80 feet near Oyster Bay and Huntington, and 40 feet at Port Jefferson, Long Island. The dip of the beds, which is the same as the slope of the unexposed floor, probably decreases toward the east and south. This old Cretaceous floor is still preserved inland in the crests of the Palisade and Watchung ridges, Schooley Mountain and Kittatinny Mountain of New Jersey and in the truncated folds of the Appalachian Mountains west of Harrisburg, Pennsylvania. Locally in Long Island the

weak upper beds of the Cretaceous series have been greatly folded and contorted by the passage of the Pleistocene glaciers over them.

The Cenozoic Era, Pleistocene Events: Four glacial and three interglacial stages are represented on Long Island. The periods of glaciation correspond to the Nebraskan, Kansan, Illinoian, and Wisconsin of the Central United States, and to the Günz, Mindel, Riss, and Würm of the Alps Mountains. Locally they have been named by Mr. M. L. Fuller, of the United States Geological Survey, the Mannetto, Jameco, Manhasset, and Wisconsin stages and are represented primarily by gravel and morainal deposits. The only ones represented within the limits of the accompanying geological map are the Manhasset and Wisconsin. The outwash, terminal moraine, till, and retreatal outwash deposits of the Wisconsin stage are far more extensive and readily examined than the similar accumulations of the older stages since they were the last and cover in large part those made during the preceding glaciations.

The First Interglacial stage, the post-Mannetto, was long, for a great erosion unconformity exists. Following the deposition of the Mannetto gravel of the First Glaciation, there was a period of uplift and erosion in which the Mannetto was cut to a depth of 300 feet below sea level, as shown by the depth of the buried Jameco channel in Long Island. The great length of this period of erosion, indicated by the almost complete removal of the thick Mannetto gravel from the Long Island region, is in harmony with the time required for the cutting of the Hudson River rock gorge to a depth of 750 feet below present sea level. The gorge proper appears to be filled solely with Pleistocene materials as indicated by the Storm King and other borings; hence, its cutting is to be referred to a date later than the deposition of the latest Tertiary beds in New Jersey.

The narrow, steep-sided and deep outer cañon of the submarine channel, p. 7, if due to stream erosion, must be referred to an elevation of great magnitude, 4800 feet, occurring at the close of the post-Mannetto erosion stage. The great drops or falls in its beds are characteristic of a juvenile stream or old one which has been rejuvenated. As only the edge of the continental shelf was notched, the epoch of maximum elevation must have been brief.

During the Second Interglacial stage, the Yarmouth of the Mississippi Valley, the Gardiners clay was deposited in Long Island. It was followed by a transitional epoch represented by the Jacob sand. Throughout the time of the Second Glaciation, the Second Interglacial, and the Third Glaciation, the channel of the Hudson remained constantly below sea level. The deposits, which have a combined thickness of about 500 feet, doubtless obliterated the upper reaches of the submarine Hudson channel.

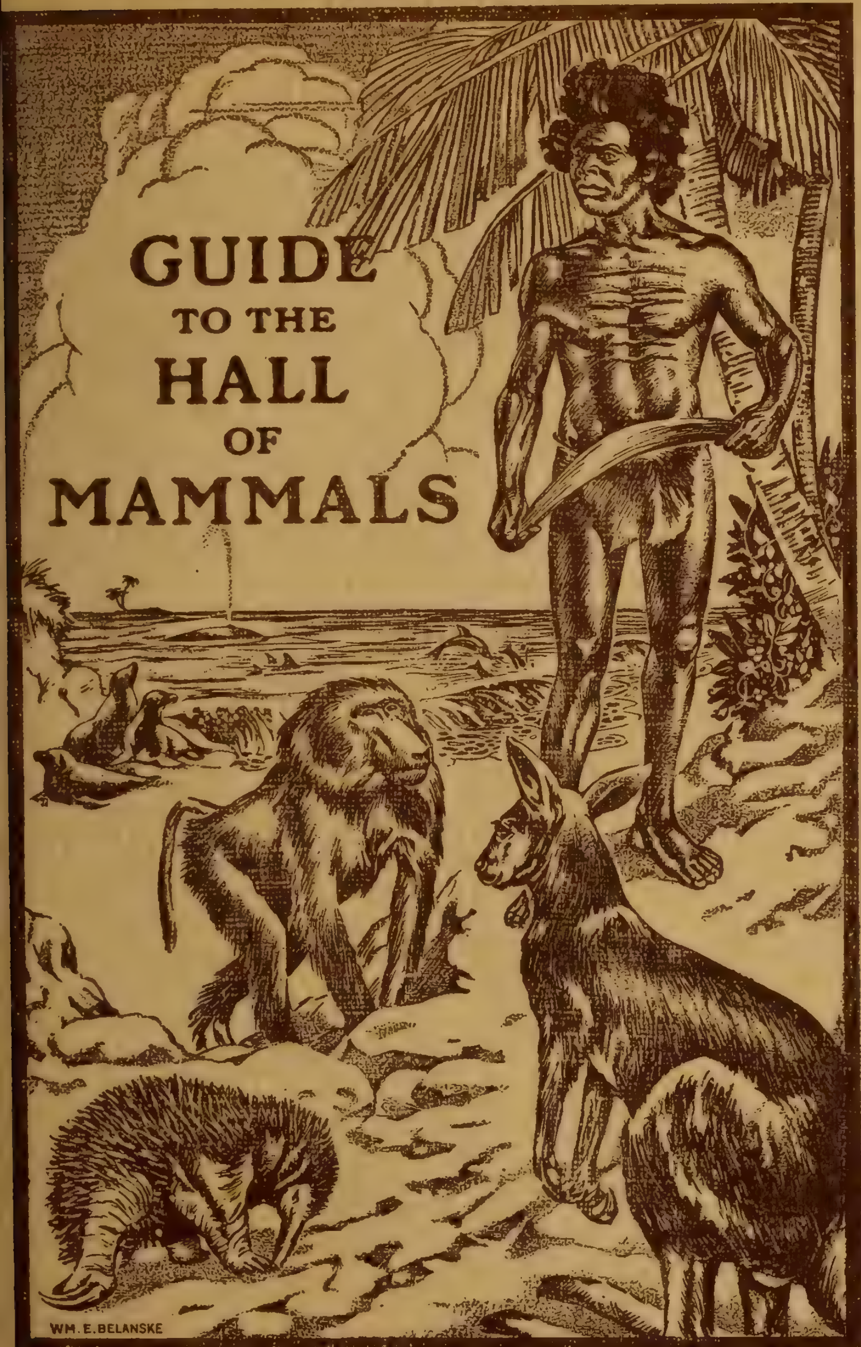
The Third Interglacial interval, the Vineyard, is represented by (a) a great erosion unconformity, and (b) the Vineyard formation, consisting of marine deposits and peat. The valleys in the Manhasset deposits, although somewhat modified and partly filled with the later Wisconsin accumulations, are known to extend some distance below sea level at many points along the north shore, indicating a former higher position of the land. The present upper submarine channel of the Hudson, which has a depth at its outer end of 350 feet, suggests that the land must have been elevated to that extent

during the Vineyard interval.

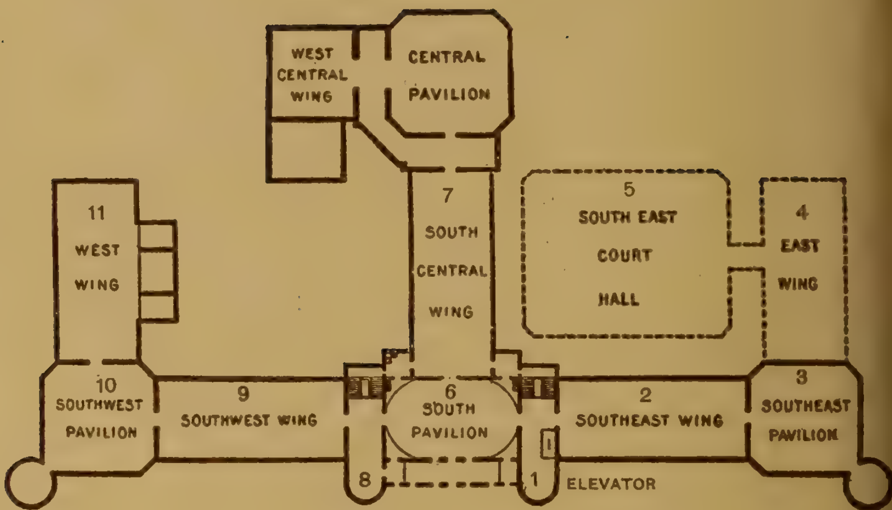
There are no erosion channels referable to Wisconsin or post-Wisconsin elevation on Long Island. The upper end of the Hudson channel, however, between Sandy Hook and Rockaway Beach, has been obliterated in part by Wisconsin outwash and in part by the shifting of the sands by the littoral currents that now sweep along the coast.

Thus in this rapid survey we have considered very briefly the Archæozoic, Proterozoic, Palæozoic, Mesozoic, (Triassic, Cretaceous), and Cenozoic (Pleistocene) series of rocks as represented in New York City and its vicinity. They are replete with interest but they represent only a few isolated and incomplete chapters of the geologic history of North America. The long Palæozoic era, including the Age of Invertebrates, Age of Fishes, and Age of Amphibians, is not represented by sediments in the area of the geologic map, pp. 10–11. The Jurassic and Lower Cretaceous periods occupying the middle portion of the Mesozoic era, the Age of Reptiles, are also not represented in this district. Likewise the Tertiary series, corresponding to the Age of Mammals, appears outside the area. The Pleistocene glacial deposits, which are contemporaneous with the Age of Man, are rather fully represented but, as yet, no human remains have been found in them in this area or anywhere in North America.

THE AMERICAN MUSEUM



OF NATURAL HISTORY



THE HALL OF MAMMALS

is on the THIRD FLOOR, SOUTHEAST WING, just to the right of the elevator. It is number 2 on the floor plan shown above

GUIDE

TO THE

HALL OF MAMMALS

BY

FREDERIC A. LUCAS

The American Museum of Natural History

Guide Leaflet No. 57

New York, October, 1923

AMERICAN · MUSEUM · PRESS

The **Guide Leaflets** describe some exhibit, or series or exhibits, of special interest or importance, treat of some branch of museum work, or, as in the present case, may deal with the contents of an entire Hall. A list of the "popular publications" of the museum may be obtained from the librarian.

GUIDE TO THE HALL OF MAMMALS

By Frederic A. Lucas

This leaflet was written in the hope that it might prove useful to classes and visitors in connection with the exhibits in the Hall of Mammals. Its object is to point out the purpose of the exhibits, to tell why the specimens are shown and what they are intended to illustrate. And for the very reason that it is not intended as a text book, but for use with the collections it has been left largely an outline to be filled by those using it.

It deals with Mammals, a term frequently confused with Animals. Strictly speaking, all living creatures are animals, but to many people, possibly the majority, animal means a mammal in distinction to birds and other creatures.

The collection was begun with the view that it might be helpful to students and scholars by providing them with a handbook in which the reading matter should be furnished by the labels and the illustrations by the objects themselves. It was also hoped that it might prove of interest to visitors and that without special effort they might get an idea of what a mammal is.

Like a book it is to be read from left to right, beginning with the Characters of Mammals and the Family Tree of Mammals at the left of the entrance, and ending with Man, who is a species of Mammal and considered by himself to be the head of his class.

The story of man is told elsewhere, his evolution and early history in the Hall of Age of Man and Hall of Archæology, the characters and customs of living races in various halls of the Department of Anthropology.

The object of the exhibits is to show the distinguishing features, or *characters of mammals*, the points wherein they agree with one another and differ from other animals; their main groups or *Orders*, and the subdivisions of their orders or *Families;* as well as the variations in the skeleton, *Modifications of structure*, whereby they are adapted to different modes of life, the whales for dwelling entirely in the sea, the seals for living in the sea or on land, the horse for land only and the sloth for the trees.

As the exhibits give a brief, but comprehensive illustration or synopsis of the points noted above, they form collectively the *Synoptic Series of Mammals.*[1]

The exhibits are divided into, or may be considered in two sections, the Systematic Series, that deals with the larger divisions of Mammals, Orders and Families, and a Special Series that deals with special features of the Class and includes examples of some of its rarer or more interesting members.

MAMMALS

Their Characters, Divisions and Modifications

Mammals are warm-blooded, backboned animals that with a few rare exceptions are born alive and nourished for a time on milk.

They may be large or small, naked, covered with hair or scales, have teeth or be toothless; live on land or in the water, swim, walk, fly or burrow in the ground, but they agree in the above particulars and are all placed in the Class Mammalia. They belong, with Birds, Reptiles, Amphibians and Fishes in one of the large groups or Phyla, of the Animal Kingdom termed Vertebrata or back-boned animals, because they all have a vertebral column or back bone. (See Family Tree of Mammals).

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[1]Note: The writer and curator is well aware that this is not an attractive title, but he has been unable to think of any other that combines brevity with accuracy and will be glad to receive suggestions in regard to it.

CHARACTERS OF MAMMALS

(First Wall Case on Left)

A technical exhibit for advanced students: it deals at length with the distinctive characters of mammals and compares, or contrasts them with the corresponding characters of reptiles, from which mammals are considered to have been derived. It is an answer to the question, What is a mammal?

FAMILY TREE OF MAMMALS

(First Pier Case on Left)

Showing the relation of mammals to other groups of animals.

Note how life began with animals of simple structure from which as time went on more complex or higher forms were evolved. The mammals appeared late in the history of the earth and stand at the top of the "Tree."

GENERAL OR SYSTEMATIC SERIES

Mammals arranged according to a given plan or system—in this case their structure. An illustration of the methods employed in classification will be found in a pier case on the North Side showing the divisions of the seals—*Pinnipedia*, based on resemblances or differences in their skulls and especially in their teeth. The mounted specimens and skeletons show the outward form and internal structure of the groups, and the maps of distribution show where they occur. The accompanying labels give information as to their general character, appearance in time and peculiarities of structure.

THE ORDERS OF MAMMALS

Following is a list of the Orders of Mammals with brief explanatory notes in regard to them. The names may appear formidable because they are unfamiliar but they are the names in general use in text-books, in many cases there are no "common" names and it is hoped that a little observation of the collections and the notes in this leaflet may cause the names used to appear a little less fearsome.

MONOTREMATA, Egg-laying Mammals, Monotremes. Include the Platypus and Echidna; termed primitive because they resemble in structure the reptiles from which mammals are believed to have been derived. They differ from all other mammals in that the young are hatched from eggs, though nourished on milk. They are placed in a group or sub class, termed *Prototheria*, the first mammals.

PLATYPUS
Ornithorhynchus paradoxus

ECHIDNA
Echidna aculeata

Information in regard to Classification, Scientific Names, and related points may be found in A First Chapter in Natural History.

MARSUPIALIA, Pouched Mammals, Opossums, Kangaroos and related animals.

The young are born at an early stage and during the first part of their life carried in a pouch. The greater number are found only in Australia. They vary greatly in form and habits and we have marsupials that are flesh eaters, grass eaters and rodents; they jump, climb, run, and a few sail like our flying squirrel. The Marsupials are given a sub class, *Metatheria*, intermediate mammals, as ranking between the

HEDGEHOG

Erinaceus europæus

An insectivore that suggests a little Porcupine

egg-laying mammals and those in which the young are well-developed when born.

The following *Orders* from Insectivores to Primates contain the vast majority of existing mammals, including those with which we are most familiar; they form a large assemblage known as *Eutheria*, the right or perfect mammals.

INSECTIVORA, Insect Eaters; animals of small size, many of them, like the mole, adapted for an underground life where they feed on worms and insect larvæ.

CHIROPTERA, Bats; the only mammals that really fly, their immensely long fingers, supporting like the ribs of an umbrella, a membrane that forms a wing. Their distribution depends mainly on temperature; when the cold puts an end to the insects on which they feed, the bats hibernate, go into winter quarters and sleep until spring. The fruit-eating bats, the largest members of the order, are found only in warm countries where they can obtain food throughout the year.

CARNIVORA or **FERÆ**, The flesh eaters or Beasts of Prey. Familiar examples are the dog and cat. The cat is "a carnivorous, fissiped, digitigrade mammal of the family *Felidæ:*" that is, it is a flesh-eating animal, whose toes are separate, that walks on the tips of its toes, nurses its young, and is a member of the Cat family.

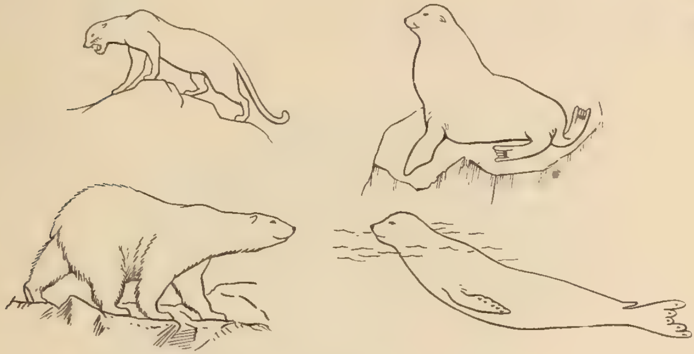
The Carnivores are divided into two great groups, the Fissipedia, whose fingers are free and the Pinnipedia whose fingers are united to form a paddle. The first group includes the majority of the flesh eaters—the Lions, Wolves, Bears and Weasels, the second the Seals and Walruses.

AN OUTLINE OF THE CLASSIFICATION OF THE BEASTS OF PREY—ORDER FERÆ

Fissipedia	**Pinnipedia**
Feet for Walking	Feet for Swimming
Cats	Walruses
Weasels	Eared Seals
Dogs	Earless Seals
Bears, etc.	

Also the cat is digitigrade—walks on its toes—and the bear is plantigrade—walks flat-footed—and the seal is pinnigrade—swims with its feet.

"Classification" is merely the orderly arrangement of animals or other objects, placing those most closely related to one another in a group by themselves and arranging the groups thus formed with reference to their degree of relationship.



TYPES OF CARNIVORES

Panther	Fur Seal
Polar Bear	Harbor Seal

RODENTIA or **GLIRES**, Gnawing Animals, including rats, mice and rabbits; mostly small animals, the giant of the order being the South American Capybara. This group contains more species and individuals than any other order and owing to their small size, adaptability and rapidity with which they breed, its members are found over the greater part of the earth. The most evident character of the order is the structure of the front teeth, incisors, which are made on the principle of some chisels, a thin cutting edge of hard enamel in front, backed with soft dentine; this wears away faster than enamel, automatically keeping the teeth sharp. The cutting teeth grow continuously and rodents *must* gnaw to keep them worn down.

BRUTA or **EDENTATA**, Sloths, Armadillos and their relations. A mixed assemblage of mammals varying greatly in outward appearance. They are "low" in their brain characters and intelligence, "low" in the simple structure of their teeth and in some features of the skeleton.

The term Edentata—toothless—is literally true in regard to the Ant Eaters, and all members of the group agree in lacking front teeth.

ANTEATER

Tamandua tetradactyla

PHOLIDOTA, Scaly Anteaters, Pangolins, Manids—one of the cases where the so-called common name conveys no idea to the average person. The members of this order are distinguished by being clad in overlapping horny scales which offer a pretty good protection when the animal coils up with the tail outside. They are confined to Tropical Africa south of the Sahara, and southern Asia. One species is noteworthy as having the longest tail of any Mammal, fifty-two vertebrae, one for every week in the year.

EFFODIENTIA, the Aard varks, so called in allusion to their burrowing habits, though the order has also been termed *Tubulidentata* in reference to the structure of the teeth which are composed of little tubes placed on end.

This order includes only two species of animals found in the warmer parts of Africa and formerly placed with the Edentates.

AARD VARK

Orycteropus ater

UNGULATA, the Hoofed Mammals, including such well known forms as sheep, deer, antelope, camels, cattle and horses. The vast majority of large quadrupeds belong in this order whose members are widely distributed over the earth, save Australasia, and were abundant until killed off by man. They are most numerous in Africa, least numerous in South America and there are none in Australia.

HYRACOIDEA, Hyraxes or Dassies, neither of which "common" names conveys any meaning, being a good illustration of the fact that a so-called "common" name may be just as meaningless to the majority of people as a scientific name. An order including a few species of small mammals looking something like rabbits, but not at all like them in any part of their structure and really related to the Rhinoceroses. The species found in Syria is the coney

mentioned in the Bible, "The conies are but a feeble folk, yet make they their homes in the rocks."

HYRAX OR DASSIE

Hyrax capensis

PROBOSCIDEA, Elephants, present and past.

"Beast that hath between its eyes a serpent for an arm." The largest of land mammals distinguished from other mammals by many well defined characters, size not being a character.

FLORIDA MANATEE

Trichecus latirostris

A member of the Order Sirenia noted on the opposite page

SIRENIA, the "Sea Cows," Manatees and Dugongs. An ancient order including but few species and these widely separated. Mostly confined to tropical, or warm waters, though one species, the Rytina or Arctic Sea Cow, the largest member of the group, was found in the north where it was exterminated by man.

CETACEA, Whales and Porpoises. Mammals adapted for living wholly in the water, often mistakenly thought to be fishes, though they breathe by lungs and not by gills and must come to the surface for air. Their fore limbs are modified into flippers, the hind limbs present as mere vestiges concealed within the body and the tail present in the shape of flukes.

COMMON DOLPHIN

Delphinus delphis

A rough and ready means of distinguishing between cetaceans and fishes is that the former have the tail, or flukes, crosswise to the body while in fishes it is always vertical, up and down.

The order contains the largest animals that have ever lived, the great Blue Whale reaching a length of 103 feet.

PRIMATES, the "highest" mammals, Man, Apes, Monkeys and Lemurs, these last widely separated from the others in characters and intelligence. Man is sometimes placed apart in a Suborder Bimana, two-handed, while his relatives are termed Quadrumana because in most of the species the big toe is opposable to the others so that the foot, like the hand, is fitted for grasping.

SPECIAL SERIES

Illustrations of the relation of internal structure to form and habits; modifications of the teeth; change of color with the season.

RELATION OF ANIMALS TO THEIR ENVIRONMENT

On the left (North) Relation of Animals to their surroundings or *Environment.* Mammals, and other animals, that dwell in deserts are pale and harmonize in color with the sand, thus illustrating protective coloration. The birds, insects and plants offer further instances of adaption; in the case of plants the leaves are reduced in size and number to lessen evaporation.

MODIFICATIONS OF THE SKELETON

The skeleton is the best, and most enduring evidence we have, of any animal's place in nature and its relationships with other animals: it is also the solution of a problem in mechanics, that of carrying a given weight and of adaptation to some particular mode of life. So the skeleton not only indicates the group of animals to which its owner belongs, but also tells of his mode of life, for it varies, or is modified, according as a creature dwells on land, lives underground, or in the water, walks, swims or flies; feeds on grass, catches insects, or preys upon its fellows.

TEETH

Their structure, location, method of implantation, growth, mode of replacement and modifications, with special reference to the teeth of mammals: Case on south or right side of hall.

ALBINOS AND MELANOS

Albinos are animals in which the coloring matter or pigment of the hair or other parts of the body is lacking. They may occur in any group of mammals.

Melanos are animals in which there is an excess of coloring matter. They occur more often than albinos and are particularly numerous in some species or in some localities. In the Grey and Fox Squirrels melanos occur so often as to form a distinct color phase, and black Leopards are common in some localities in southern India and the Malay Peninsula. Baghera of the "Jungle Stories" was a Black Leopard.

ANIMALS THAT LOOK ALIKE BUT ARE DIFFERENT

These specimens illustrate the point that because two animals look alike they are not necessarily related, differences in the skeleton (*Structural Differences*) being much more important than mere resemblance, and furnishing the characters on which classification, or the grouping of animals according to their relationships is based.

The Flying Squirrel and little Acrobates both sail from tree to tree, but one is a rodent and one is a marsupial; the Squirrel and Squirrel Shrew look alike and have the same habits, but one is a rodent and one an insectivore.

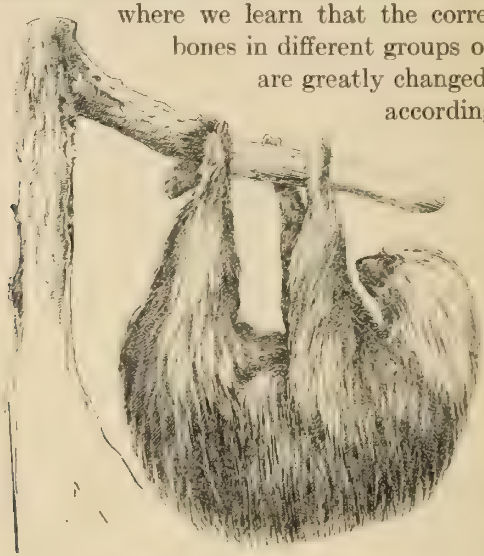
FLYING SQUIRREL. FLYING PHALANGER

The Echidna, the Hedgehog and the Porcupine all have spines but belong to widely separated orders of Mammals.

The Tasmanian Wolf and the Coyote are much like one another in form and habits, both being flesh eaters, but one is a marsupial and the other a true carnivore.

RELATION BETWEEN FORM AND HABITS

According to their mode of life, the limbs of mammals are modified to form fingers, feet, paddles or wings. The underlying changes are shown in the *Modifications for Locomotion* where we learn that the corresponding bones in different groups of animals are greatly changed in shape according to their function.

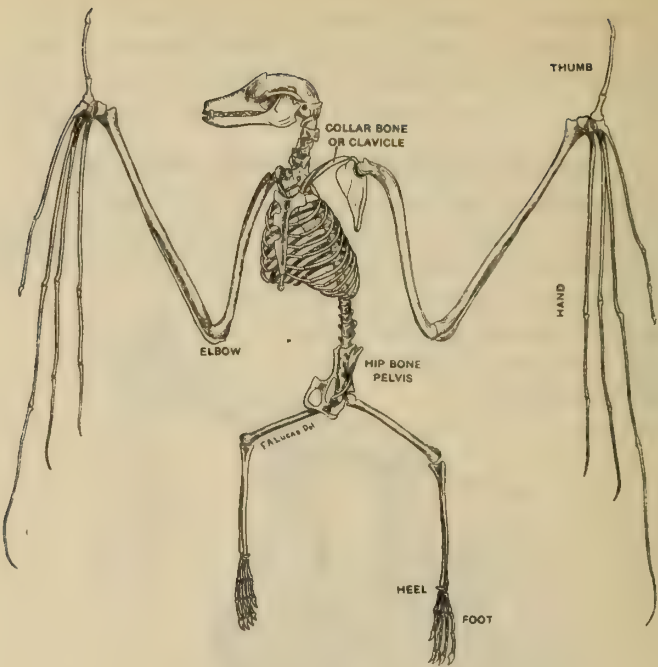


TWO-TOED SLOTH

Cholopus didactylus whose feet are hooks. The sloth hangs below the branches.

COLOR CHANGE IN THE VARYING HARE

In northern regions many mammals and some birds change their coats with the season, becoming white in winter, a familiar example being the Ermine and Weasel. It is a change of hair and not in the hair, the gray coat being shed and the white one put on early in winter and the process reversed in spring.



FRUIT BAT

Pteropus species

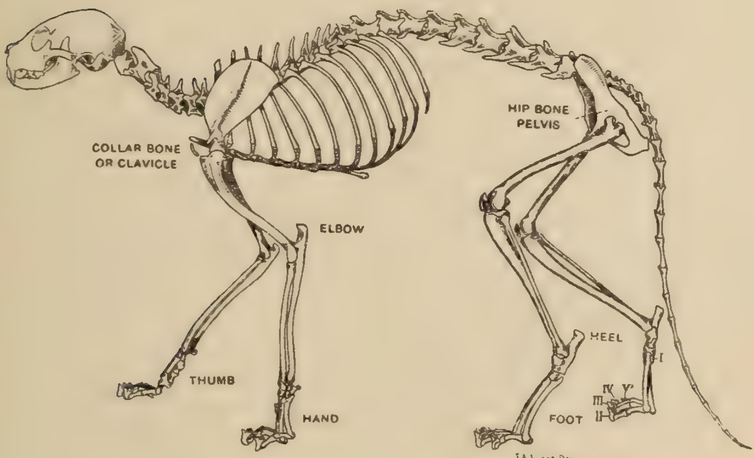
As in other bats the fore legs are modified, or changed, for flight, all the bones, but especially the fingers, being greatly lengthened to form supports for the membrane that serves as a wing. The fruit bats fly with rather slow wing beats and the outer part of the wing is proportionately larger and more rounded than in their smaller, more active relatives. The hind feet are little used, serving mainly as hooks by which the bat hangs itself up—head downwards—to sleep.

MODIFICATIONS FOR LOCOMOTION

Shows the variations in the skeleton, and especially in the limbs, by which animals are adapted for walking, jumping, flying or swimming. The snake is introduced to show that it is possible for an animal to run, climb or swim with no limbs at all.

The series of limbs in a nearby case shows details of structure, the bones being colored so that the same bone in the various feet may be readily distinguished.

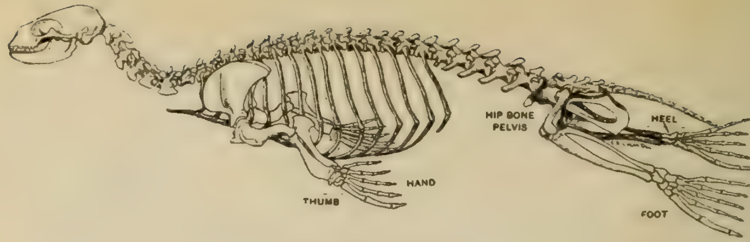
See also Relation between Form and Habits.



THE CAT

Felis domestica

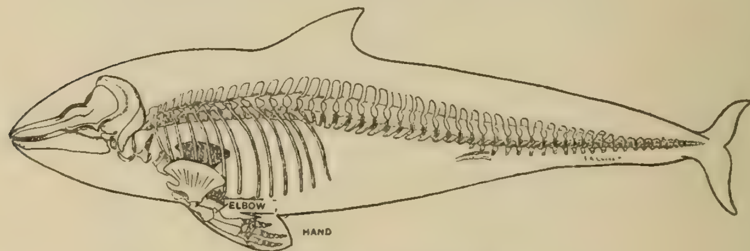
An example of a skeleton slightly modified for free and rapid movements and for jumping—this last point is indicated by the length of the foot bones and the size of the heel and elbow. The skeleton of the cat may serve as a convenient term of comparison with the skeletons of other animals.



HARBOR SEAL

Phoca vitulina

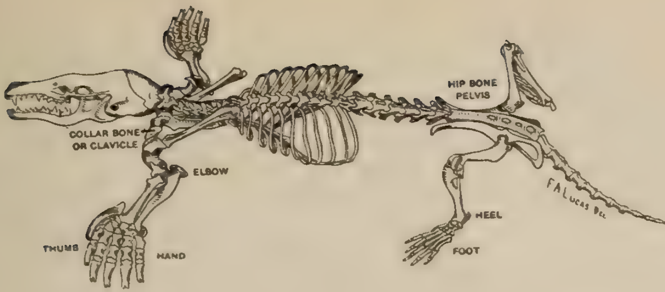
Like other seals this species passes some time on land, coming out to bask in the sun, but the legs are of little use for locomotion on land. All four limbs are changed into paddles for swimming, though the hair seals swim mainly with their hind feet and the eared seals with their front feet.



HARBOR PORPOISE

Phocaena communis

The porpoise is an example of a mammal fitted for living only in the water, and represents the extreme of modification among mammals. The hind limbs have been lost, their only vestiges being two little bones that represent the pelvis, or hip bone: the front limbs have been changed into rigid paddles, fit only for balancing or steering; locomotion is effected by what is really the tip of the tail, which has been developed into flukes for swimming. Note that unlike the tail of fishes the flukes of whales and porpoises contain no bones.



MOLE

Scalops aquaticus

Modifications of the skeleton for an underground life are most evident in the fore limbs which perform the work of digging, being for this purpose short and stout, the hands large, and turned on edge. (In the figure the hand is turned down to show the bones).

The foot is also strengthened by the addition of a bone running along the edge of the foot, shown in the picture. This bone is not found in other mammals.

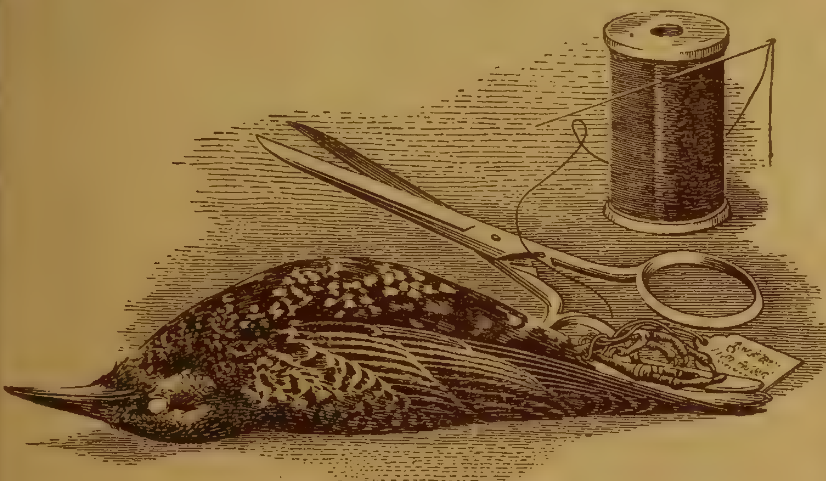
The skeleton of the mole illustrates the fact that a bone of little importance in one group of animals may be of great value in another.

In the cat and the seal, in which there is no particular strain on the fore feet and great freedom of movement is needed, the clavicle or collar bone is very small, or absent: it is also absent in the porpoise in which the fore limb is scarcely used.

In the bat and the mole in which flying or digging bring great strain on the fore limb, the collar bone is very strong to brace the shoulder. This is particularly evident in the mole.

THE AMERICAN MUSEUM OF NATURAL HISTORY

PREPARATION OF BIRDS FOR STUDY



THE COMPLETED SKIN

By JAMES P. CHAPIN

GUIDE LEAFLET No. 58

NOTE

This leaflet is one of a series intended to furnish accurate information in regard to the preparation of specimens of various kinds for Museum purposes.

The following have been issued and may be purchased at the sales booth or from the Librarian; others are in the course of preparation:

The Preparation of Birds for Study
By James P. Chapin. Price 15 cents

How to Collect and Preserve Insects
By Frank E. Lutz. Price 10 cents

Suggestions to Collectors of Reptiles and Amphibians
May be had on application to the Curator, Dept. of Herpetology

THE PREPARATION OF BIRDS FOR STUDY

INSTRUCTIONS FOR THE PROPER PREPARATION OF BIRD SKINS AND SKELETONS FOR STUDY AND FUTURE MOUNTING

By
JAMES P. CHAPIN
Associate Curator of Birds

The American Museum of Natural History
New York
1923

THE PRESERVATION OF BIRDS FOR STUDY

Travelers in foreign parts often fail to realize what valuable service they could render to the museums of America. They are apt to consider the birds of the world so well known as scarcely to need further collecting; whereas, in addition to the numerous species that remain to be discovered, many which have long been known are still unrepresented by a single specimen in any museum of the United States.

To aid in the improvement of our collections, the following instructions are offered for the use of our friends. The scientific value of a skin is greatly enhanced by correct preparation and labeling. To illustrate the successive steps a large number of figures are included, which have been drawn by M. Frazee Belcher.

Collections of birds are composed chiefly of "skins," which resemble in general appearance a dead bird. They exhibit most of the external features of the living bird, the structure and colors of its plumage, as well as the general form of beak, wings, and feet. Bird skins may subsequently be mounted, if desired; but most of them are intended for study rather than for exhibition. Many a skin not fit for mounting is yet of distinct scientific value, provided its history is preserved on the label.

For study of the internal anatomy, skeletons and birds in the flesh preserved in alcohol or weak formalin are also necessary. It is customary to preserve but few examples of a species in this manner, whereas a series of skins is desirable, the external characters being more variable, and more commonly studied by systematic workers. Opportunities for preserving large birds in fluid seldom offer themselves, but their skeletons may be roughly prepared and dried, the final cleaning to be done at home. The skeletons of small birds are so fragile that it is usually better to bring the specimens back whole, preserved in fluid, which permits study of the muscles and viscera as well. The bones can also be cleaned—even though the birds have been kept in formalin—but alcohol is very much better for the purpose.

The preservation of birds as dried mummies, with the aid of carbolic acid or injections of formalin, is to be discouraged. They become very brittle, are difficult to examine, and are subject to the attacks of insects.

The Making of a Birdskin

Instruments

Do not accustom yourself to an unnecessary variety of tools. The fewer they are the more quickly you are sure to work. If nothing else were available, a penknife would suffice to preserve the skin of an ordinary bird. For small and medium-sized birds the following instruments are amply sufficient:

1 scalpel, with blade about 1½ inches long;
1 pair of sharp-pointed scissors, blade 2 to 2½ inches long—the stronger they are, the longer you can do without a second pair;
1 pair of forceps, about 5 inches in length, with long, slender tips;
1 thin metal knitting needle;
1 pair of cutting pliers, for the wire used in necks;
Ordinary sewing needles (sizes 2 to 8) and cotton thread (Nos. 8, 36, 80), pins, of nickeled brass, not of steel;
1 medium-sized carborundum stone, for sharpening knives and scalpel;
1 rather stiff artist's brush, for washing small spots of blood from plumage, and for moistening skin;
1 old nail-brush, for drying and fluffing the plumage;
Annealed, galvanized iron wire, of sizes 11, 16, 22;
1 folding metric rule;
1 pair of dividers, for taking measurements.

For larger and tougher birds, one may add to the kit:
1 thin-bladed kitchen knife;
1 pair of bone-cutters or short, heavy shears;
1 longer pair of forceps, about 10 inches over all, with tips not very slender; they will be used for stuffing skins.

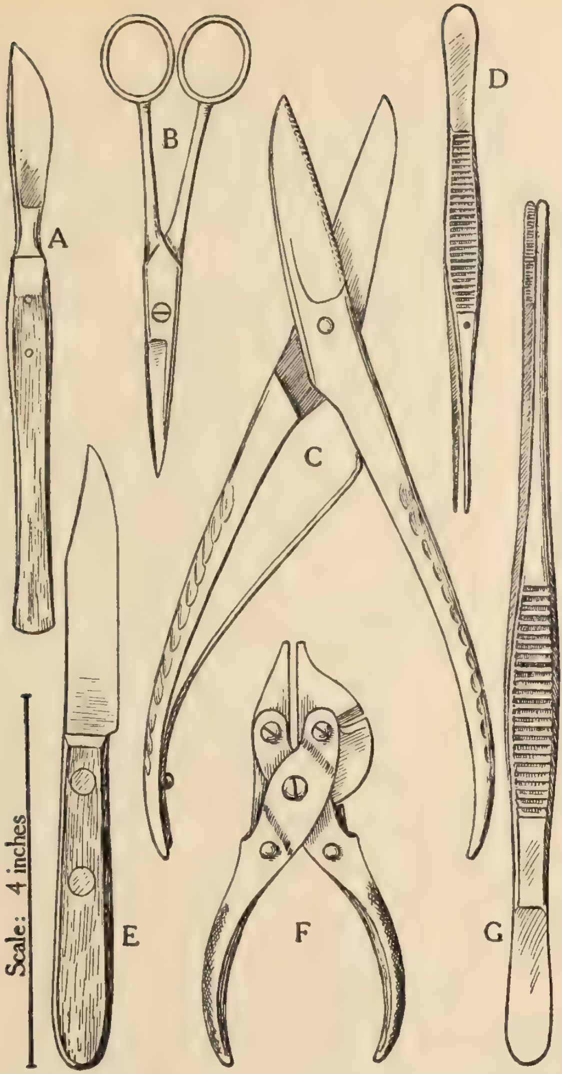


Fig. 1. Principal instruments used for skinning birds: A, scalpel; B, scissors; C, bone shears; D, small forceps; E, kitchen knife; F, cutting pliers; G, long forceps. Their dimensions may be figured from the accompanying scale.

Other Materials[1]

Small birdskins are best stuffed with good, long-fibred cotton, not necessarily absorbent; larger ones with tow and "excelsior" wood-shavings, when available. In case of need, green moss may be used after thorough drying, or fine dry grass, or the dry husks of maize—in short, almost any soft, dry vegetable material.

The inside of the skins is to be dusted with powdered white arsenic (=arsenic trioxid), or powdered arsenic and alum (in equal parts by volume). The latter mixture is especially suited for large birds' skins, and for skins of all sizes in a damp climate. The arsenic is used for its permanent effect in preventing insects from eating the skin, rather than for any immediate action as a preservative. It should never be omitted; and used with ordinary care, it offers no danger to the health of the collector. Arsenical soap is more tedious to manipulate, and not necessary.[2] Put no salt on a bird's skin, save for temporary preservation, as described on page 33.

For preventing the feathers from adhering to the flesh as it is exposed in skinning, for absorbing blood, and for drying parts of the plumage that may have to be washed, fine corn-meal is used. Where this cannot be had, any other starchy meal which does not become sticky when wet will serve, and dry sawdust may also be used. Natives of the tropics frequently prepare coarse flours from rice, millet, or manioc, which are suited to the purpose. Failing these, dry powdered clay, or sand, or wood ashes, may often be employed. Plaster

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[1]It is not feasible to list all the equipment which a bird collector may find useful. For supplies used in drying and packing birdskins, see pp. 38–40; for preservation of birds in fluid, pp. 41, 42; and for simple soldering outfit, p. 42. Preparing rough skeletons requires no special tools, but arsenical soap solution is useful in safeguarding them, as explained on p. 44

[2]Arsenical soap is sometimes very useful to paint on beak and feet externally, to prevent attacks by insects. See page 39.

of Paris has been much used by taxidermists, its only fault being that it is almost sure to leave a light powdery bloom on the feathers, particularly if they are of dark color.

When birds are very fat, benzine or carbon tetrachlorid may be used to wash the grease from skin or plumage. Sheets of paper, thin cheesecloth, or mosquito netting are used to wrap large birdskins while drying, instead of the thin layer of cotton which is recommended for small specimens. A collector's tag of convenient size is shown on page 37. Never neglect to take a generous supply of naphthaline, it is the cheapest form of insurance against destruction of skins by insects, and in the tropics is absolutely essential to success.

Care of the Bird before Skinning

By proper handling of the freshly killed bird, a great deal of trouble can be avoided. Pick it up by the bill or feet, and scrape off with a knife-blade any drops of blood which may adhere to the feathers. A small wad of dampened cotton will be useful to wipe off blood-stains, before they have time to dry. Any large shot-hole may be stopped with a bit of cotton, after which corn-meal should be sprinkled among the bases of the neighboring feathers. Open the mouth, and insert a large plug of cotton, pushing it down the throat to prevent the oozing out of blood or other fluids.

In very warm climates, where small insectivorous birds have a way of putrifying and losing feathers on throat and abdomen within a few hours, it is often worth while to carry a hypodermic syringe, with which to inject a preservative into the abdomen. Insert the needle through the vent, pushing it into the body cavity about the intestines. Very weak formalin (1 part to 25 of water) may be used, if there is no objection to the slight hardening of the belly skin; but a saturated solution of alum (*i.e.*, so strong it can dissolve no more alum) does not have this fault, though it retards decay appreciably. Carbolic acid may likewise be employed. Such preservatives

aid greatly in the subsequent determination of the birds sex, by keeping its organs in far better condition, especially when they are undeveloped. For the throat, a little of the preserving solution (preferably alum) is squirted into the gullet before it is plugged. Alcohol is not to be recommended, for it runs out again too easily on to the plumage.

Next make a cornucopia of stiff paper, drop the bird into it head foremost, seeing that the bill is not turned forward on to the throat; and if the bird is not too large, fold in the edges of the cornucopia and place it in a basket or other receptacle where it will not be pressed upon, have its tail damaged, or be shaken about. In a warm climate, avoid the use of a metal box for carrying birds, as they will become overheated. Decomposition of the skin results in a blistering or sloughing of the epidermis, loosening the feathers so that they fall out when the bird is handled.

Measuring Fresh Birds

The dimensions of bill, wing, and tail are usually measured from the dried skin, and there is no advantage in taking them from the fresh bird. In certain cases, particularly with large species, it is of interest to record the spread of wings, from tip to tip, and the total length, from tip of beak to end of tail. The "length of body" would be a useful measurement to take from every species; this would be the distance in a straight line from the anterior surface of the shoulder to the vent, or, if the bird is already skinned, to the tip of the small bone (pubis) which extends down in the belly wall close to the vent. In birds of ordinary size it may be measured with a pair of dividers. Always use the metric system in preference to inches.

Skinning the Bird

(1) See that the throat is tightly plugged with dry, non-absorbent cotton. Do not plug the nostrils, for the pressure

may change their form, which it is desirable to preserve. If blood oozes from the nostrils, place a strip of cotton over them and across the forehead, stuffing the ends down on each side into the throat, and then add another wad in the throat to hold them fast. This will keep most of the blood away from the plumage of the head during the operation of skinning. If the eyeball has been ruptured by the shot, pull it out with the forceps, and fill the cavity with meal.

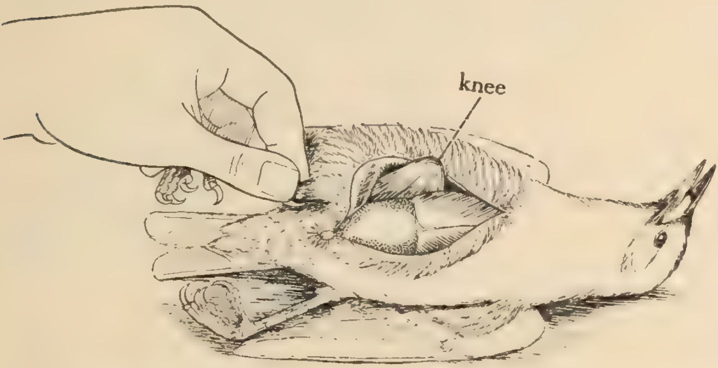

Fig. 2. The first knee has been exposed. Cut through joint and flesh, down to the skin.

(2) Lay the bird on its back. Separate the feathers down the mid-line of the breast, where the skin will be found more or less bare. With scalpel or scissors make a longitudinal incision through the skin, from about midway down the breast bone, backward to the vent, into which the cut may be continued. Try not to cut into the wall of the abdomen, although a small hole will not matter.

(3) Taking the very edges of the skin by the finger nails, and pushing with the handle of the scalpel between the skin and flesh, separate the skin from the body, farther and farther back on both sides, until you lay bare the bird's knees. Sprinkle cornmeal upon the flesh as it is exposed, to dry it, and to prevent the feathers from adhering.

(4) Take hold of one of the feet from the outside, push the knee farther up into view inside the skin, as in Fig. 2. With the scissors, clip the leg entirely in two at the knee-joint, inside the skin. Do the same with the other leg.

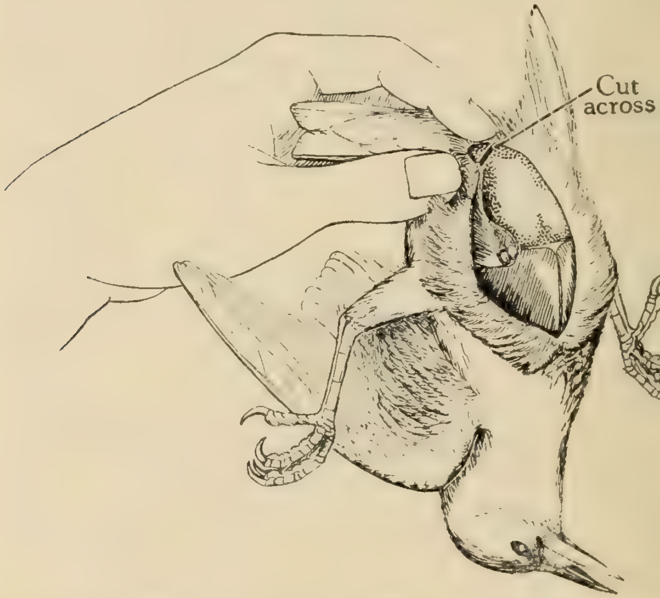

Fig. 3. While holding the base of the tail, press it upward with the second finger, and cut through with scissors to the skin of the back, on the line indicated.

(5) On both sides of the abdomen separate the skin as far as possible, and sprinkle meal. With the scissors, first cut through the lower end of the intestine, close to the vent, and then through the base of the tail, far enough forward to avoid the bases of the tail-quills. (See Fig. 3.) Continue until you see the skin all across, and the tail is completely severed from the body, inside the skin. A small hole may perhaps be cut accidentally, but remember that a small hole entirely under

the plumage matters little, and a larger one can usually be sewed together without detracting from the value of the specimen.

(6) With the left hand grasp firmly one of the thighs, to support the body of the bird. With the thumb of the right

Fig. 4. Supporting the body by one of the thighs, skin forward over flanks and rump.

hand, aided occasionally by the scalpel, separate the skin of the rump from the body, as in Fig. 4. Continue forward, turning the skin of the specimen partly inside out, and removing the body gradually from the skin.[1] Use an abundance of meal to keep the feathers from being soiled, and try to keep the fingers interposed between the feathers and the flesh, as the work proceeds.

[1]In the case of large birds, a cord may be tied about the body just in front of the thighs, as soon as the skin has been peeled off to that point, and the bird may then be hung at a convenient height. This saves the effort of supporting its whole weight with the left hand.

Fig. 5. The body has been almost entirely skinned, so that the bases of the wings are exposed, ready to be cut through at shoulder joint.

(7) The bases of the wings will soon appear. (Fig. 5.) Cut them off at or near the shoulder joint. Continue turning the skin forward. The neck is soon reached; and the skin will turn back easily over it, till the base of the head is reached.

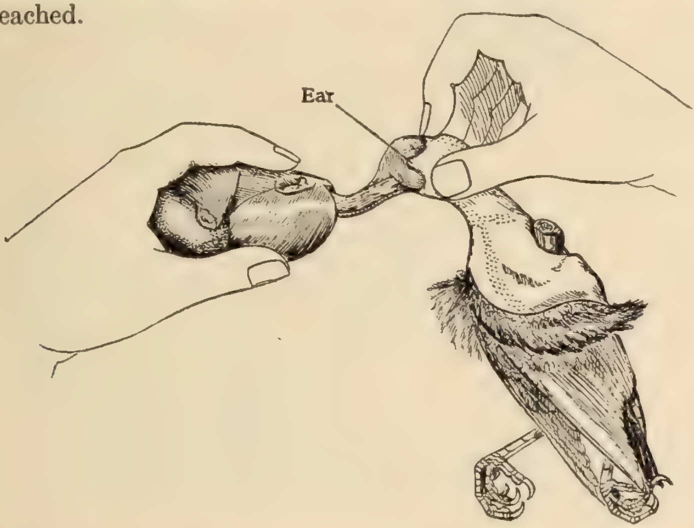

Fig. 6. Pushing the skin forward over the head. The ear has been reached, and its skin may be pulled out with the finger nails, or in a larger bird cut through close to the skull.

(8) Work the skin carefully over the head, *pushing* with the finger nails close to the skull, rather than pulling on the skin of the neck.[1] As the back of the head emerges, the ears appear (Fig. 6), and by seizing them firmly with the forceps or between the nails of thumb and index finger, they can be pulled from their hollows. Only in large birds is it necessary to cut the skin of the ears, as close to the skull as possible.

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[1]In many woodpeckers and ducks the head is too large to come through the skin of the neck. If after patient trial it cannot be persuaded, cut off the neck close to the base of the skull, and proceed as indicated on page 25.

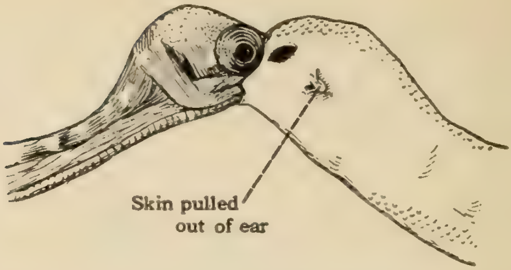

Fig. 7. The head is skinned to the base of the bill.

(9) Next the dark-colored eye-balls appear, and the thin transparent membrane is cut which attaches the eyelids to the eyeball. Continue cutting forward until the lids are completely free from the eyes, and above all avoid cutting the edges of the lids, which so often bear a circlet of small feathers.

(10) Continue skinning forward to the very base of the bill, above and below, as in Fig. 7. This is especially important in large birds, for it enables this part of the skin to dry and

Fig. 8. The first cut for the removal of the brain is through the thin wall between the orbits, without injuring roof of skull.

retain its feathers. The skin must remain attached at the base of the bill.

(11) Pry the eyeballs from their sockets with the handle of the scalpel, but avoid breaking them. Cut away the tongue and floor of the throat.

(12) With the scissors make a cut directly across the roof of the mouth, below the orbits, but without cutting the lateral supports of either the upper or the lower jaws (Fig. 8).

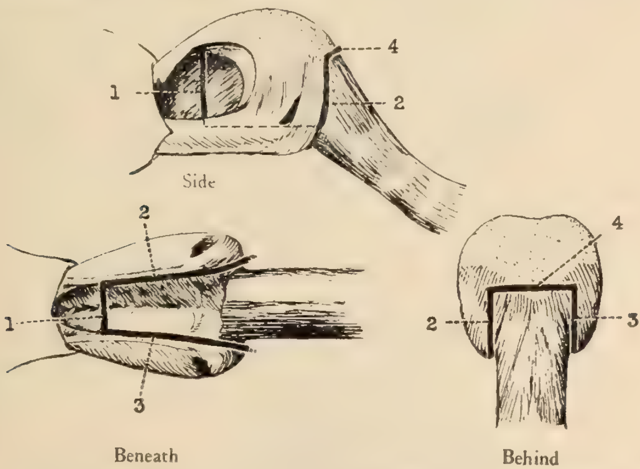

Fig. 9. Four cuts with the scissors suffice for the removal of the base of skull, and of the brain. These are numbered in the order in which they are made.

Again with the scissors, make incisions from each end of the preceding cut backward along the base of the skull, within the branches of the mandibles, as far as the rear of the skull, at the sides of the attachment of the neck. Connect the posterior ends of these cuts by a fourth, across the back of the skull, just above the juncture of the neck.[1] These cuts are shown in Fig. 9.

[1]In large birds the same cuts are made in the skull, but with stronger bone shears, instead of the scissors.

(13) Pulling the neck from the head will now remove the base of the skull and part of the brain, the remainder of which is to be scooped out with the handle of the scalpel. Large openings should connect the brain-cavity with the orbits.

(14) Cut away any loose flesh from the skull, and powder it generously, as well as the skin of head and neck, with arsenic and alum, which is shaken from a piece of cotton held in the forceps.[1]

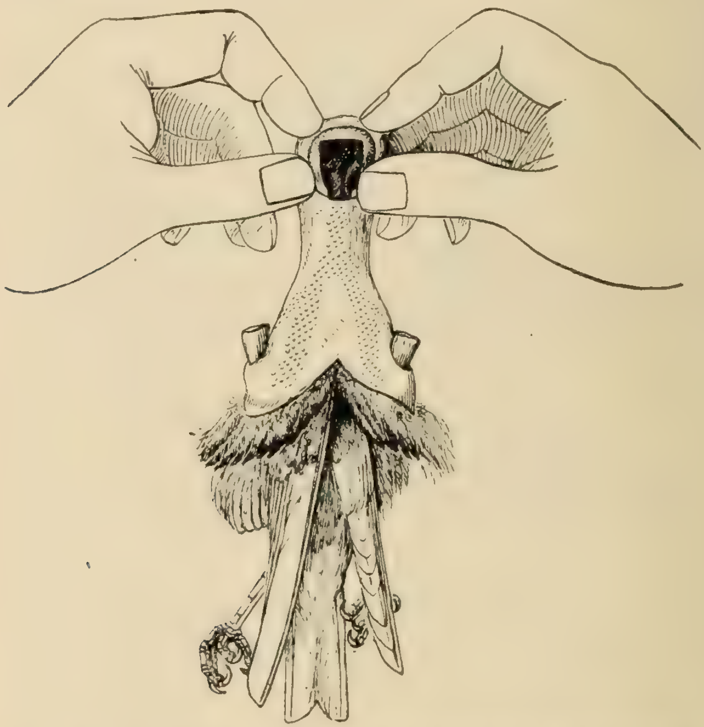

Fig. 10. Turning the skin of the head back over the empty skull, which has been cleaned and poisoned.

[1]A dried rabbit foot is even better for the purpose.

(15) If the skin has dried so as not to turn back easily, moisten it slightly. The head is now turned right side out, by gradual coaxing with the fingers, rather than by pulling. (Fig. 10.) No stuffing is as yet placed in the head. Straighten out the feathers with small forceps and a needle, especially about the cheeks and eyes.

(16) Pull the wing-bones inward, and clean the wings, one after the other. Push the skin away as far as the elbow. Then push forward the skin along the *upper* or *anterior* side of the forearm, leaving the quills (secondaries) attached to the lower of its two bones. The muscles of the forearm, in all small birds, can be removed from the upper side, almost as far out as the wrist. There is no objection to the removal of the upper of the two forearm bones (radius) when snipping out the flesh. The upper arm bone (humerus) should, however, be cleaned of flesh and left attached to the bone (ulna) remaining in the skin of the forearm. These bones are illustrated in Fig. 11.

(17) Another method of skinning the wing, which makes for more speed in preparing birds of medium size, such as pigeons, consists in separating the quills from the lower bone of the forearm with the scalpel. This allows greater freedom in removing the muscles of the forearm, but the bone of the upper arm should not be removed, and later the skin should always be pulled so that the wing-quills extend back again to the elbow. Otherwise the form of the wing becomes unnaturally distorted. In really large birds, the wing is opened from the outside, on its lower surface; and the quills must always be left attached to the bone.

(18) Before turning the wings right side out again, proceed to skin the legs, pushing the skin down as far as there are any feathers, and then removing all flesh from the bones. In large birds see carefully to the farthest (outermost) parts that are feathered, as they are very apt to decay, and give them an extra share of arsenic and alum. Do not attempt

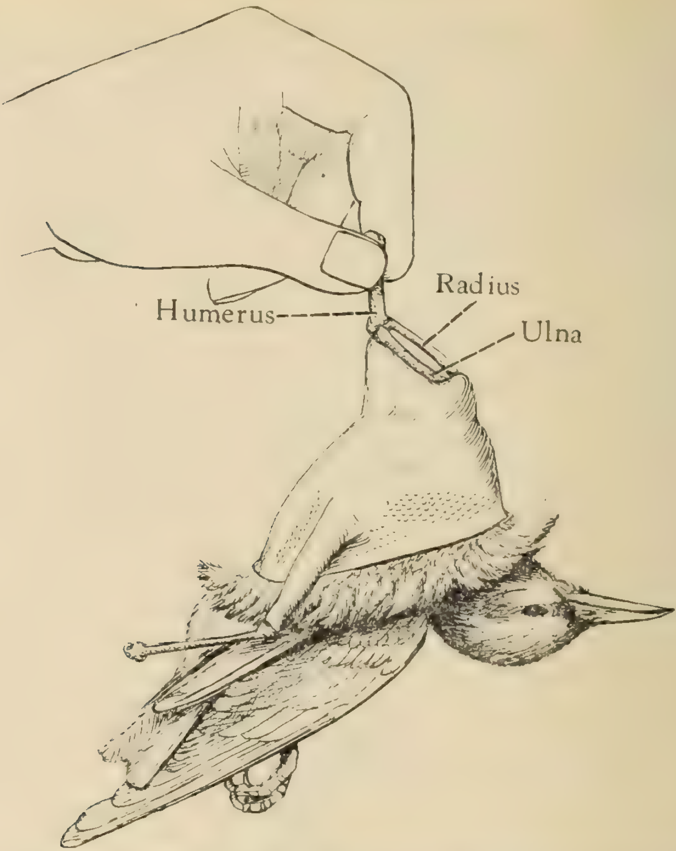

Fig. 11. The flesh has been cleaned from wing and leg; this treatment suffices for all small birds.

to turn over the scaly skin of the feet, as it will injure the scutes.

(19) Remove as much flesh as possible from the base of the tail, and cut out the fat of the oil-gland on its upper side. Avoid injury to the bases of the quills, or they will fall out. Most of the bone may be removed, except the very tip, between the middle feathers.

(20) Remove all fat and any bits of flesh from the inside of the whole body skin. (See page 26 for the treatment of fat.)

(21) Through the forward end of each scapular feather-tract a stitch is to be taken. (Fig. 12.) Draw them together with the thread, and tie firmly (with a "square" knot) at a distance approximating that which would separate them on

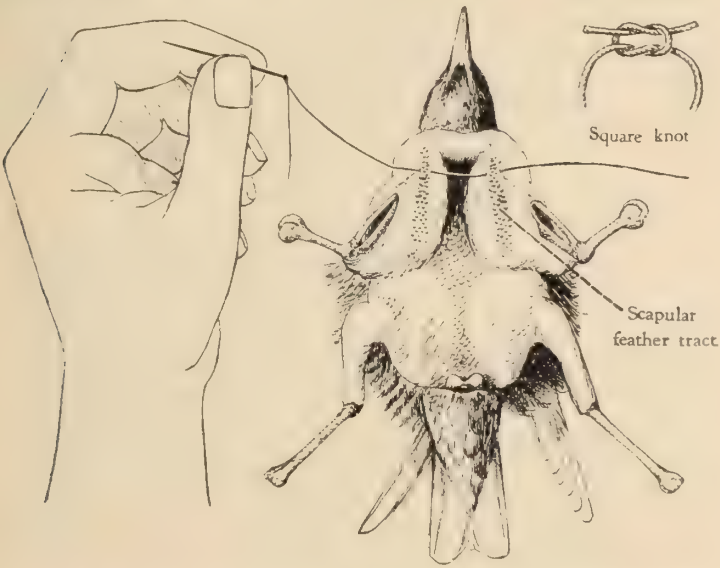

Fig. 12. Where to take the stitches to hold the scapular feather-tracts together.

the back of the live bird. This will make the arrangement of the wings and adjoining feathers vastly easier. Tying the wing-bones together is another means to the same end.

(22) Powder the whole inner surface of the skin, especially that of wings, feet, and base of tail with arsenic and alum. Wind a little cotton about the leg bones, and turn the whole skin right side out.

Cleaning the Plumage

(23) Look for any blood spots on the plumage, and wash them clean, using a small brush, rather stiff, dipped in clean water. When the blood has been entirely removed, the feathers are dried by rubbing them with dry meal, raising the feathers and brushing them lightly forward and back with the nail-brush. Add more meal, rub into the bases of the feathers, and repeat until the feathers are entirely dry. Then remove all meal by shaking and a vigorous use of the nail brush. When the cornmeal becomes damp it should be dried in the sun or over a fire.

Filling out the Skin

(24) Birdskins are not left flat, but are filled out to the size of the body removed, so as to show the relation of the plumage to the different parts of the body. First roll a fluff of cotton on the end of the fine-pointed forceps into a small hard ball about the size of the eye. Taking the ball firmly in the forceps, pass it up through the skin of the neck, through the back of the skull, and lodge it in the orbit. Another ball fills the other orbit, and a little cotton in the brain-space holds them firm. The eyelids are arranged from the outside with a needle, as though the eyes were wide open, so that a smooth cotton surface shows.

(25) The stuffing for body and neck is put in together. On a soft iron or brass wire[1], somewhat longer than the stuffing is to be, roll cotton first in the form of the neck, tapering to a point anteriorly.[2] Farther back more cotton is tightly rolled,

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[1]A slender, pointed stick may be used instead, though less convenient. In making up the skins of very small birds it is scarcely necessary to use either stick or wire. The cotton may be wound on a thin knitting needle, which is loosened by a reverse twist and withdrawn, after the stuffing has been arranged inside the skin.

[2]Dip the wire in water first, if necessary, to make the cotton adhere tightly.

until it approximates the size of the body you have removed. (Fig. 13.) It must never be larger. The cotton neck protruding from the cotton "body" should not exceed the length of

Fig. 13. Rolling the artificial body of cotton or tow on a wire.

the bird's neck as it lies before you, for though it will run up into the throat, it cannot bend into the natural curve of the neck of the bird.

(26) Open the skin and insert the pointed anterior end of the stuffing (at tip of wire or stick), running it up the neck and into the throat, until its tip appears in the mouth. Pull back the skin of the bird until it encloses the cotton body. (Fig. 14.)

Fig. 14. Inserting the stuffing in the skin; the pointed artificial neck runs up between the bases of the lower mandible.

(27) You are now ready to arrange the skin properly with the forceps, folding the wings close to the body and on the back rather than down on the breast, and pushing the skin of chest and hind-neck forward or backward, as the smoothing of

the plumage may require. The skin of the ear-region or crown may be raised with the point of a fine needle and moved about slightly until the feathers all lie naturally.

(28) Once you are satisfied with the general appearance, which should resemble that of a dead bird lying on its back, cut or break off the posterior, projecting part of the wire or stick, and sew up the incision of the belly with a few stitches.[1] Do not draw the sides too closely together, as the edges of the skin will always have shrunk somewhat. The feathers will readily hide the slit. If the borders of the skin have dried too much, moisten them inside before sewing; the feathers may then be more easily arranged.

(29) Tie the mandibles together, so that the bill remains closed as it would in life. The tip of the upper one should often project very slightly beyond the lower. A well-closed bill is essential to a good skin. The thread may be passed through the nostrils with a fine needle, provided it does not injure them, and tied around the lower mandible. In very thick-billed birds the thread may not hold; in such cases a pin inserted between the rami of the lower mandible will serve to shut the bill. Here, too, beware of injury to the nostrils.

(30) Cross the legs and extend the toes moderately. Attach a label (see page 36), tying the string preferably with square knots, so firmly as to leave no chance of its falling off subsequently. The label must bear at least the sex of the specimen, the locality, and the date.

(31) Let the skin slip through the palm of your half opened hand (Fig. 15), pressing the wings into place, and arranging the tail and legs. Lay the skin, back down, upon a thin sheet of cotton broad enough to enclose it. Draw the lateral edges of the cotton up around the sides, as in Fig. 16, so that they hold in the wings and enfold the whole skin, overlapping on

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[1]In very small birds one stitch is enough.

Fig. 15. The finished birdskin is molded in the palm of the hand, the wings being pressed in against the back, so they do not hide the sides of the breast. [redacted]

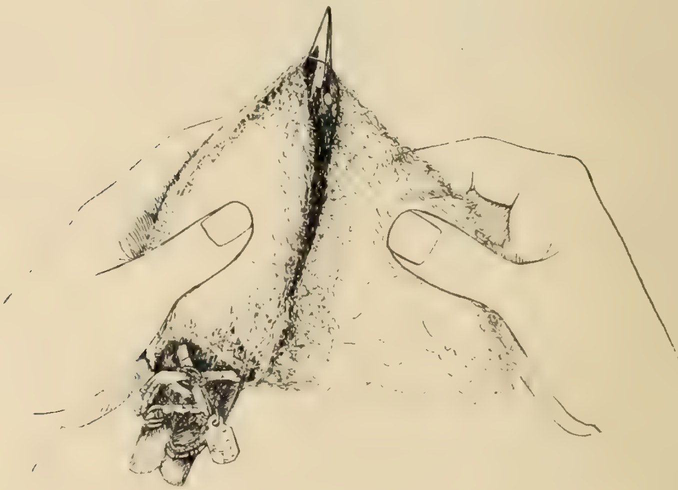

Fig. 16. Wrapping the finished skin in a thin sheet of cotton, before it is laid away to dry.

the throat and breast, preserving the desired form and the smoothness of the plumage.[1]

(32) Put the skin away in a cool airy place to dry, where it will be safe from insects or any other small animals that might destroy it. (See page 38 for drying racks.)

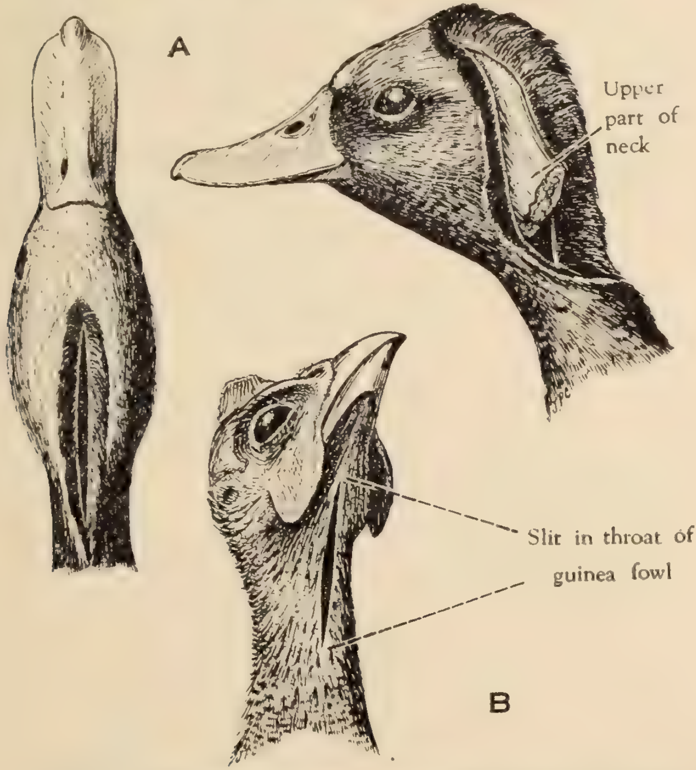

Fig. 17. Opening the heads of thin-necked birds: (A) a duck, (B) a guinea fowl.

Large-headed Birds

When the skinning of the head cannot be done through the neck, as in the case described on page 13, the neck alone is

[1]Instead of wrapping with cotton, some collectors prefer to push the finished skin, bill foremost, into a cornucopia or a cylinder of paper.

removed, the skin turned right side out, and a slit is cut between the feathers from the middle of the crown as far back on the nape as may be necessary to allow turning out the skull and the removal of eyes, brain, and all flesh about the head. (Fig. 17, A.) The same cuts are made in the base of the skull as in the usual procedure. Through the slit in the skin of the nape the necessary stuffing is afterward introduced into the orbits, and a little cotton may be placed between the skull and the skin of the cheeks, if much flesh has been removed. Then the slit is sewed together again, and will usually be hidden by the feathers. When a considerable amount of flesh has to be removed from the skull of a large bird, it is well to replace it by inserting pads of cotton with the forceps just before the skin is filled out again.

In a few cases the slit is better made on the lower side along the mid-line of the throat. Birds like the horned Guinea-fowl are best treated this way (Fig. 17, B), for the excrescence on the crown must not be separated from the skull. The head cannot be completely skinned; but the soft parts of the throat, the eyes, and the brain can be removed from below. The fact that the slit remains visible is of no moment. Hawks and other diurnal birds of prey have a bony shield over the eye, projecting from the region of the forehead. It is best kept attached to the skull.

Fatty Birds

Small patches of fat may be removed from the inside of the skin by scraping with the scalpel, enough cornmeal being used to prevent the oil from reaching the plumage. Water-fowl are often so greasy that the removal of the fat is almost certain to soil the feathers. It must never be left on the skin. Scrape away from the tail and in the direction of the head; far fewer holes in the skin will result. The cornmeal or other absorbent powder (see page 6) may be heated in a pan over a fire (though never hot enough to scorch the feathers) and it

will absorb oil much more effectively. Where gasoline, benzine, or naphtha is available, the skin after careful scraping may be dipped and washed in any of these fluids, and then dried by shaking meal into the feathers and beating and brushing gently. For small birds, carbon tetrachlorid (often sold under trade names such as "Carbona") may be used to the same purpose and without danger from fire. These degreasing fluids must not be expected to remove dried blood at the same time; that should previously have been sponged off with water. Many taxidermists, in preparing fatty water birds like ducks, prefer to make the initial slit in the body skin down one side, beneath the wing, instead of on the middle of the belly. The short dense feathering of the underside is more easily arranged afterward; and the plumage along the mid-ventral line is preserved from soiling by grease. Such a procedure is seldom necessary, but by no means objectionable.

Wings and Feet of Large Birds

Special attention is required by the wings and feet of large birds, for with only the treatment described above, they would be certain to decay and lose feathers or scales before they could be dried. In warm climates especially, every bird as large as a partridge must have a slit made along the underside of the wing, out to the tip, in the line where fewest feathers grow. (See Fig. 18.) Then all fleshy parts and large tendons are removed. The bases of the large quills (secondaries) are not to be separated from the bone (ulna), for this would make their subsequent arrangement difficult—particularly in a large bird which is to be mounted. It is especially important to separate the skin of the wrist joint, around to the upper surface of the wing, from the bones at that spot, and to insert a generous dose of arsenic and alum. Failing this, in large birds, the feathers of the "bend of the wing" are more than apt to become loosened through "sweating" of the skin.

The slit of the lower surface of the wing may be closed with a few stitches, but drying will be more rapid if it is not too carefully sewn up. Try to keep the feathers near it clean. In large birds that require such treatment, it will be necessary also to wrap the bone of the upper arm with cotton or tow, to keep it from contact with the skin, for drying will be slower than in small birds.

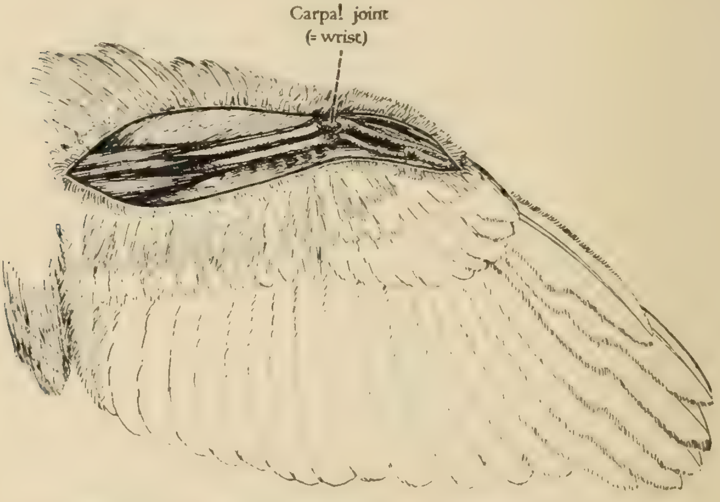

Fig. 18. The opening made along the under side of a large bird's wing, for the removal of flesh. Be sure to skin around over the *upper* side of the wrist joint, and poison well with arsenic.

The feet in large birds dry so slowly that the skin often decomposes, and the scutes become loosened. To obviate this the tendons of both tarsus and toes are removed, together with any small muscles present. After all the other skinning operations have been completed, cut a longitudinal slit in the median pad of the sole. The tendons of the toes all converge here, and by pushing the tip of the heavy forceps beneath them, from the side, they may be pulled entirely out of

the tarsus. (Fig. 19.) The ends attached to the toes may then be cut, or if the toes are very fleshy, they also may be split open longitudinally from below, and more of their tendons excised.

With large herons and other similar wading birds, another slit should be made on the *inner* side of the heel joint (near the upper end of the shank), parallel to the long axis of the

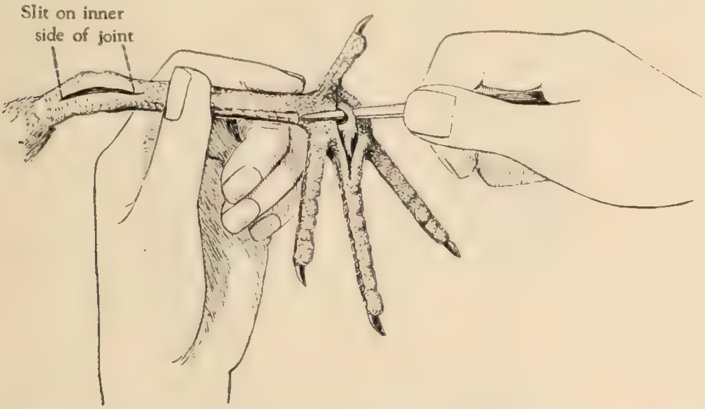

Fig. 19. Pulling the tendons from the leg of a large wading bird. Note also the incision on the inner side of the shank, near its upper joint. It need not be made till after the tendons have been drawn; through it the skin is loosened and poisoned all around the joint.

limb, and the skin separated as far around the joint as practicable, to be treated with arsenic and alum. With a wire or the long forceps, get as much of this preservative as possible up into the space whence the tendons have been withdrawn.

The feet of pelicans and large vultures are so difficult to preserve in a warm moist climate that the safest way is to slit the skin down the whole length of the tarsus, on its inner side. Remove all flesh and tendons, dust with arsenic and alum, and do not sew up very tightly. Split the underside of the toes, out to the last joint, removing the tendons.

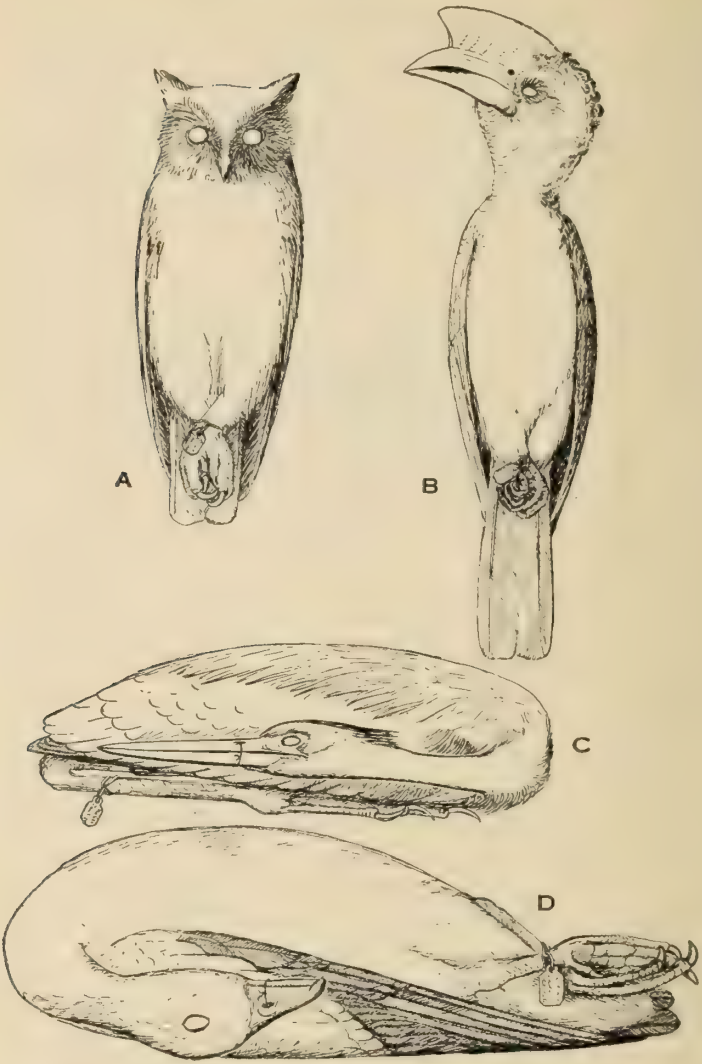

Fig. 20. Method of arranging skins of some large birds. A, owl, B, hornbill; C, large heron; D, goose.

Making up Skins of Large Birds

It is obvious that specimens of large birds, with long necks and limbs, if made up in the same way as small birds, would be very difficult to transport or store in boxes. When a bird exceeds a length of 2½ feet, either the neck or the feet, perhaps both, will have to be doubled over. A wire, not a stick, is therefore to be put in the neck; and after the skin has been filled out and sewed up, it is bent into the desired form, care being taken that no part of the bird's plumage shall become entirely hidden. Bend the neck down one side of the body, outside the wing, rather than upon the middle of the breast or back. Methods of treating birds of different sorts will be suggested by the sketches in Fig. 20. For large birds the artificial body, preferably of "excelsior" bound with heavy thread, is made smaller than the real body. The neck is wound of cotton or tow, and these softer materials are used to fill the space remaining beneath the skin. Make such skins only large enough to display all parts of the plumage. Neither can large skins be wrapped in cotton; strips of paper pinned round them, or some open-mesh cloth, will keep them in shape until dry.

Treatment of the Head in Owls

The eyes of Owls have a peculiar shape, the front protruding in such a way that if the whole orbits are filled with *round* balls of cotton, the facial expression will be largely lost.

Treat the eyes of owls as follows: Do not remove them from the orbit, in which they are fixed rigidly. Cut away the transparent skin (the cornea) in front of pupil and iris; then with the small forceps and a small wad of cotton force out all the liquid from within the eye, drying the interior with cornmeal. Take care that the liquid does not fall on the feathers.

The brain is removed through the base of the skull as usual; but there will be no opening from the brain-space to the orbit, for the latter is still filled by the shell of the eyeball, as in Fig. 21.

So instead of stuffing out the eyes from behind, round lumps of cotton are wedged into the front of the emptied eyeballs, through the lids, after the skin of the head has been turned back, and when the skin is finally being filled out.

The false neck, with its stick or wire, is not inserted into the throat of an owl, but is wedged tightly into the brain-

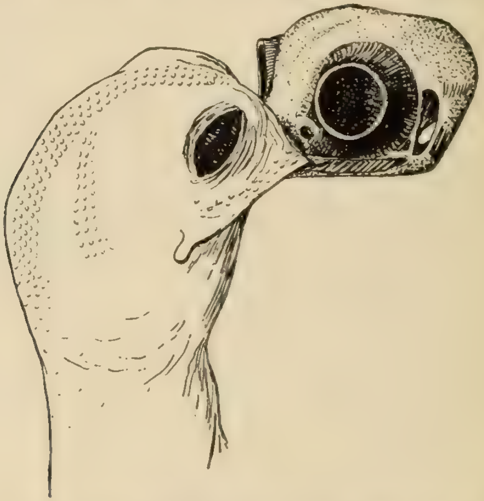

Fig. 21. Owl's head after skinning and cleaning; to show the way the empty eyeball is retained.

space at the back of the skull. This will bring the head and face into a far more owl-like position. (Fig. 20, A.) A projecting wire point may be left at the anterior end of the false neck, to be pushed through the top of the skull and bent over outside the skin. It will hold the head on more securely.

Temporary Preparation of Some Large Birds

The large flightless birds such as the ostrich, cassowaries, and their allies are not to be prepared according to the foregoing method, but must be treated more as a large mammal

would be, though the bones of wings and feet, and the skull are retained. The feet especially are to be more fully skinned so that the skin nowhere lies closely against the bone. Only just enough hay or other dry stuffing is used to keep the two sides of the skin apart, and no cuts are sewn up. Instead of arsenic and alum use salt, in a dry climate, or one part salt to three of alum in a humid one. Dry the skin as thoroughly as possible, and fold into a bundle. Never pack in the same box with other skins not treated with salt.

Large, greasy seabirds, and fatty ducks or geese, often impose serious delays upon the collector. To save valuable time they may be skinned out completely, and thoroughly salted, without too close attention to the grease, provided blood stains are carefully removed. Their preparation can be completed by a taxidermist even several months later. In general this procedure is not recommended, for the longer the skins are kept, the more work is involved in their subsequent preparation. In the humid tropics it is not to be thought of.

Determination of Sex

Inspection of the plumage can in no case be relied upon for the bird's sex. Dissection is the only method; and where wounds or incipient decomposition have destroyed the evidence, do not write the sex upon the label without a question mark.

When the body is completely removed from its skin, cut open the left side from the vent to the anterior ribs. Force the edges apart, and pressing the intestines aside, look for the sexual organs, which will be found in the small of the back close to the backbone, and near the forward ends of the kidneys, which fill the roof of the abdominal cavity. They are shown in Fig. 22.

The male organs (testes), two in number, are usually dull white but occasionally much darker, and lie side by side.

They are of smooth rounded or ovoid form, large and conspicuous in the breeding season; but they may become extremely small in winter. Do not confuse them with the "adrenal bodies," smaller and flatter bodies (yellow or orange), lying a little farther forward, *in* the forward border of the kidneys.

The female organs consist usually of a single ovary, lying a little to the left side. A vestige of the right ovary may be present. In the non-breeding season the ovary is a mass of

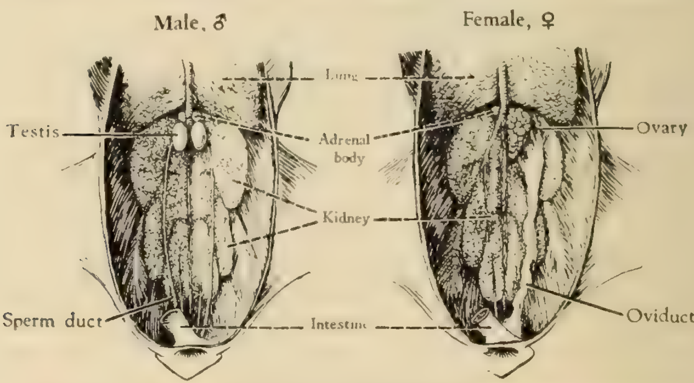

Fig. 22. Dissections of male and female birds, to show the reproductive organs, by which the sex is recognized, and adjacent structures.

small ova or rudiments of eggs, much less regular in shape than the testis of the male, and likely to be flattened, with evident granular structure. The female has adrenal bodies the same as the male. As the time for laying approaches, some of the ova become greatly enlarged, to form the yolks of the eggs. At this time too, the oviduct, a tube leading from the neighborhood of the ovary down the left side to the vent, becomes conspicuous—being usually whitish.

Determination of Age

From the condition of the sexual organs, and that of the bird's whole body, the bones in particular, the collector ought

to be able to detect signs of immaturity far more accurately than is possible from a dried skin. He might note his opinion on the label, using "ad." for adult, and "im." for immature, the latter designating any bird which has not assumed its full plumage.

Fortunately there is a simple method of determining, in the case of practically all perching birds (=ordinary song-birds and their near allies) whether the specimen is a bird of the year or not. In the nestling the bony roof of the brain-case is very thin and transparent, formed of a single thin sheet of

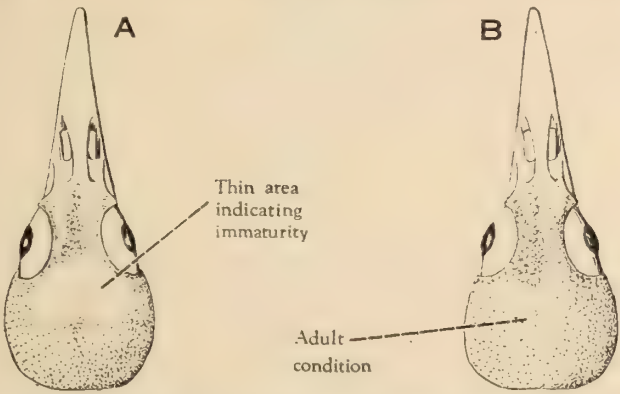

Fig. 23. Skull roof of (A) immature and (B) adult perching birds, to show the clear, thin area which indicates a young bird.

bone; that of the adult is more opaque, being formed of two layers of bone, separated by air spaces traversed by fine bony rods. Holding an adult skull up to the light, after removal of the brain, one will note that the roof of the skull, back of the eyes, shows fine dark specks all over. (Fig. 23, B). By reflected light these specks may look lighter than the neighboring bone.

As the young bird develops, the transparent area of the skull top becomes restricted, the dotted structure appearing

around its edges, especially behind, until after three months there is only a relatively small area where a single layer of bone persists. (Fig. 23, A.) This is usually near the mid-line, just behind the orbits; but in some families such as the swallows the last traces of these areas are found farther back, and more laterally placed. After some six months this sign of immaturity is completely lost.

Perching birds which are thus found to be immature should be noted on the label or in the field catalog as "s.n.o." (=skull not ossified); others which have skulls of adult structure, "s.o." (=skull ossified).

Do not attempt to use this method for other groups of birds until by careful study it is found reliable. Woodpeckers and other families of small birds may have skulls of such different structure that it cannot be applied.

Notes on Stomach Contents

Information which one may wish to preserve as to the habits of a bird should certainly include the results of examination of stomach and crop. The ornithologist will seldom be competent to name accurately all the insects, other animals, or fruits which have been eaten. It will nevertheless be worth while to have a list of the insects arranged according to orders or common names and numbers of individuals consumed, or brief mention of the nature of fruits or other objects swallowed. In the case of any species whose diet offers particular interest, the stomachs may be removed entire, labeled to correspond with the individual specimen, and preserved in alcohol or formalin, for future examination by experts at home.

The Label

The label is tied securely to the crossed feet of the birdskin, as described on page 23. As a rule the collector's label need not exceed 1 or 1½ inches in length and ¾ inch in width. It

will remain attached to the skin even when a museum label is added later. When writing on either side of the label, always keep the string to the left; this facilitates its reading. Examples are given in Fig. 24.

(1) Sex.—The spear and shield of Mars (♂) are used as the sign of the male sex, the mirror of Venus (♀) as that of the female.[1]

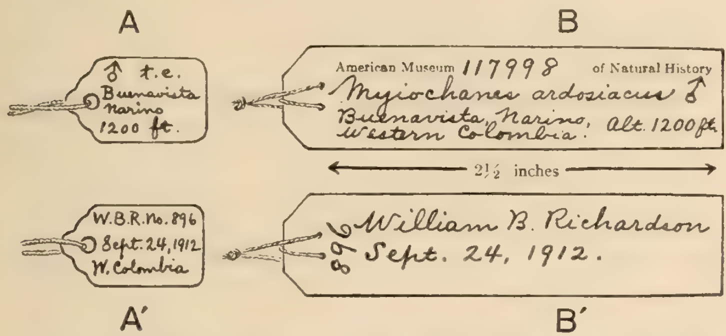

Fig. 24. Sample labels: A, front, and A′, back of collector's tag; B and B′, front and back of permanent museum label.

The condition of the reproductive organs is of interest as indicating sexual maturity or the reverse, of the individual, as well as the season of reproduction. It may be noted on the field label by means of the following abbreviations:

"t.e." = testes enlarged, when the increased size would indicate that breeding was under way.

"t.n.e." = testes not enlarged, when there is no possibility of the bird being in condition to breed.

Intermediate conditions may be indicated by "t.so.e." (= testes somewhat enlarged), and "t.sl.e." (= testes slightly enlarged). Corresponding conditions of the ovary would be written "o.e." "o.n.e." and so on.

[1]Museum experience shows the necessity of writing the sex mark with the greatest care. The worst offence, perhaps, is the use of an inverted ♀ to mean male.

(2) Locality where the bird was taken, not abbreviated so as to be unintelligible save to the collector himself. Always give the state or country, as well. In mountainous regions the altitude is an essential adjunct to the locality.

(3) Date when the bird was taken. Do not use an Arabic numeral to indicate the month, for different usage in America and in Europe often makes it impossible to decipher. Even a Roman numeral is not so clear as a three-letter abbreviation of the name of the month. Every letter on the label must be written legibly.

These three items must never be omitted from a label, for a simple catalog number on the field label is of no interest if the notebook with the data is lost. But since it is advisable to have a field label of small size, the more lengthy remarks as to age, ripeness of the reproductive organs and color of unfeathered parts (eye, beak, feet, and any naked skin) may be confided to the field catalog. In general, however, the more information on the label the better. 7×9 inches is a good size for the notebook. In it one may add anything that seems of interest with regard to the bird's habitat, its food, nesting, migrations, and ecological status. In the field notebook write on only one side of the sheet, so that pages or parts of them may be cut out and reassembled, if desirable, according to species, at some future time. This will save the trouble of recopying half of the writing.

The Drying of Birdskins

Use every means to dry the specimens promptly, without exposing them to excessive heat. In a dry or cold climate there is no difficulty, but in a tropical rainy season it may become necessary to place them in the sunshine as often as the clouds part, or to hang them in the neighborhood of a fire, though not in the smoke. Never place them in air-tight boxes till thoroughly dry. Some sort of a crate enclosed with wire-gauze will protect the specimens from mice and insects

meanwhile, or they may be placed on flat rectangles of substantial wire netting, swinging shelf-like, one above the other, by strings attached to their corners. Such shelves should fit in one of the trunks or boxes, so as to be stowed away in the bottom when not in use. Insects may be discouraged from climbing along the cord which sustains such a drying rack by wetting it with kerosene or coal-oil.

For traveling there is nothing so effective as a specially constructed drying box, with open spaces on several sides, covered with wire gauze, and fitted inside with several light trays, of varying depth. The bottom of the trays is of wire netting, and they are crossed by upright slats to keep the birdskins in place. A waterproof canvas cover will keep off rain, on the march; and it may be put over the box at night to lessen humidity. Beware of small ants which invade the drying box and eat small holes everywhere in the specimens. Napthaline flakes sprinkled over the skins will protect them temporarily.

Beetles (*Dermestes* and allies) will often gnaw at the horny sheath of the bill or the scutes of the feet, while the skins are drying. A simple way to discourage them is to paint all such parts, as soon as the specimen is made up, with a thin solution of arsenical soap, which will dry and leave almost no trace. Insects seem to be aware of the presence of the poison without tasting it.

Arsenical soap for this purpose may be made by boiling white arsenic powder a few hours in a thick solution of laundry soap—in an old pot, and *out-of-doors*—until all the arsenic is dissolved or at least held in suspension. The proportions may be about one tablespoon full of arsenic to a small cake of soap.

Packing of Birdskins

A soldered tin box encased in a wooden one is the ideal packing, but is seldom available and rarely necessary. Wooden packing boxes may be made sufficiently tight; and

if plenty of naphthaline flakes or moth-balls of the same chemical be scattered within, they will need no further inspection before arrival at their destination. Besides preventing the ravages of insects, naphthaline has a beneficent action in discouraging mold, if used generously.[1]

Never pack birdskins permanently till they are thoroughly dry. A single moist skin of a large bird may do great harm to the rest of the contents of a box. Never pack in the same box any other skin which has been treated with salt, for should it pass through a rainy district the salt will inevitably absorb moisture. Salted skins of large mammals must be kept by themselves.

Burlap dipped in tar is often used to envelop bales of goods shipped to the tropics, and this material tacked over the outside of the box will give a decided protection from rain and from the attacks of termites or white ants. The box may be lined with it, provided that plenty of paper is added to prevent the tar from touching the specimens.

The individual birdskins, with or without their cotton wrapping, are rolled in cylinders of paper and packed tightly enough to prevent any displacement during transportation. If rather thin paper is used, and the smaller specimens are placed carefully in the hollows left between the larger ones, it is astonishing how many will go into the box. This is often of prime importance in overland transportation.

Skeletons or skulls must not be packed with birdskins unless the bones have been poisoned with arsenic, provided also that there is plenty of naphthaline to deal with the insects which are almost certain to be introduced with such bones. No heavy object is to be included in a box of birdskins, for it will shake about and break many of them.

[1]Paradichlorobenzene (of which "globol" and "paracide" are trade-names) is a more energetic insecticide than naphthaline, but it evaporates far more rapidly than naphthaline, and is therefore less suitable for field work.

Customs Regulations on Entering the United States

With few exceptions the importation of wild birds' skins or plumage is forbidden, save when they are intended for scientific purposes, and addressed either to a museum or to a person holding a Federal permit to collect birds in the United States. Do not try, therefore, to bring them through as baggage, without special declaration. Specimens for the American Museum of Natural History should be clearly addressed to the museum, and may be safely turned over to the Custom Office at the port of entry, if so demanded. Notify the Director of the Museum, at the same time, of the arrival of the collection.

Preservation in Fluid

The colors of the plumage may change when the bird is thus preserved, so that the specimens are of use only for anatomical study. The preserving fluids used are alcohol (about 85%), or formaldehyde (=formalin) at about 3%. Alcohol is preferable when available; some kinds of denatured spirit will serve satisfactorily, provided they do not become cloudy on mixing with water. Strong commercial formalin is usually a 40% solution. Mix one part of such formalin with 15 parts of water. Adding common salt (two tablespoons per quart of formalin solution) prevents the extreme hardening so common with formolized specimens.

The preserving fluids must penetrate the interior of the bird's body. The abdomen and all the larger fleshy masses may be injected with a large hypodermic syringe, if it is to be had. Usually a simple slit through the wall of the abdomen, without disturbing the viscera (intestines, etc.), will allow sufficient penetration by the preservative.

Each specimen should have a label, bearing at least the locality and date. The sex will not be determined until the bird is dissected at home. The label may be of stout paper

which is not affected by fluid, or it may be a tag of pure sheet tin or of lead, with a number stamped on it. Data may be written on paper either with a soft lead pencil, or with waterproof India ink, the latter being thoroughly dried before immersion.

Alcohol in which fresh birds have been dropped will absorb water from them, and become weaker. It is necessary to change it for fresh alcohol before packing for shipment. A few spoonfuls of strong formaldehyde may be added to strengthen a formalin solution, but this is seldom necessary.

For small birds in fluid, glass jars such as are used for preserving fruit will generally suffice, if they are surrounded when shipped with straw or other fiber. It may often be necessary to place the specimens in tins,[1] which need not be entirely filled with fluid when they are soldered up, provided the birds have been thoroughly preserved for some time. Soldering is not a difficult task if a few rules are borne in mind. The metal to be joined must be clean and bright. The point of the soldering-iron must be clean and have a film of molten solder adhering to it. To assure the adhesion of the molten solder both to the soldering-iron and to the metal to be joined, use a strong, reliable flux such as hydrochloric (=muriatic) acid into which a bit of zinc has been placed. "Soldering pastes" may work, but often fail when one is least able to replace them with acid. To keep the tip of the soldering-iron clean, during the course of the work, it may be rubbed occasionally on a block or lump of sal ammoniac.

The specimens must not shake around in the jars or tins. Pack them tightly, and wrap if necessary in pieces of cheesecloth.

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[1] "Friction-top" tins are the most convenient, but others will serve as well, especially with formalin.

Preparing Rough Skeletons of Birds

Large birds will generally have their bones preserved in this manner. Thorough cleaning is not the aim; as much flesh is left adhering to them as will soon dry, and the ligaments are wanted to keep the bones attached to one another. If cleaning were too thorough in the field, many of the bones might drop off before the skeleton were safely home.

First remove the skin roughly, without including in it any of the bones. In most cases, this skin should be labeled to correspond with the bones from the same individual, and kept; it will be of great value in assuring the specific identification. Disembowel the bird, taking care not to cut the breast bone, ribs, or the small bones near the vent. Detach the legs from the body at the hip-joint and remove the flesh, taking care not to remove the knee-cap.

The flesh may be removed from the wings without separating them from the shoulder; but great care must be taken in removing the large wing-quills not to lose the small bones of the wing tip, especially the one in the alula or bastard wing. From this indeed the feathers need not be removed, and the outermost three wing feathers may likewise be left untouched.

Other parts requiring special attention are the ploughshare-bone at the base of the tail-quills, the slender points on the under side of the neck vertebræ, and those projecting back from the ribs. It frequently happens that many of the tendons become ossified, as they do in the leg of a turkey. Look out for such on the under side of the neck, in the legs and wings, and along the sides of the back, and do not tear off the muscles as you would if preparing a skin.

Considerable flesh may be left on the neck and back, for it will dry easily, but the large breast muscles are to be cut away. The hyoid arch, or bones supporting the tongue and attached to the windpipe, should be saved, as should also the

windpipe itself whenever, as in many ducks, it has bony structures developed in part of its length.

The whole neck is kept attached to the body skeleton, and it is carefully separated from the base of the skull, without cutting any bones. The brain of small birds need not be removed, in larger ones it is taken out cautiously, with a loop of wire inserted through the hole by which the spinal column comes out of the skull.

In many birds, and especially in birds of prey, there is a ring of bones surrounding the pupil of the eye. They are not very visible, being enclosed in the front wall of the eyeball. It is therefore best not to remove the eyeball, but simply to puncture it to allow the escape of its fluid contents.

Cormorants have a small bone attached to the back of the skull; other birds have projections of bone at the hinder angle of the lower jaw; and some diving birds have elongate processes at the elbow or knee. So it is a good rule not to trim up a bird's skull, or even its limbs, too closely.

Fold up the legs, and place them, with the skull, inside the chest cavity. Do the same with the wings or fold them alongside the body, thus making a bundle which is held together by a few strings till dry. It may be hung up in the meantime by a string attached to the neck; and a thin piece of wood, tied securely to one of the larger bones (the coracoid, for instance, as in Fig. 25), should bear a catalog number, written with a very black lead pencil.

The data to be entered in the catalog are much the same as those for a skin: Sex (determined by dissection when disemboweling the specimen), locality, and date.

To avoid all difficulties with beetles (*Dermestes*, etc.) which swarm upon dried bones in all tropical countries, dip the whole skeleton, as soon as it is thoroughly dried, into a weak solution (of merely milky tint) of arsenical soap, and hang it up again to dry. If the beetles are allowed to eat away the flesh, many of the smaller bones may be separated,

and are almost certain to be lost. For added protection the dried skeleton may be sewn in a piece of cotton cloth.

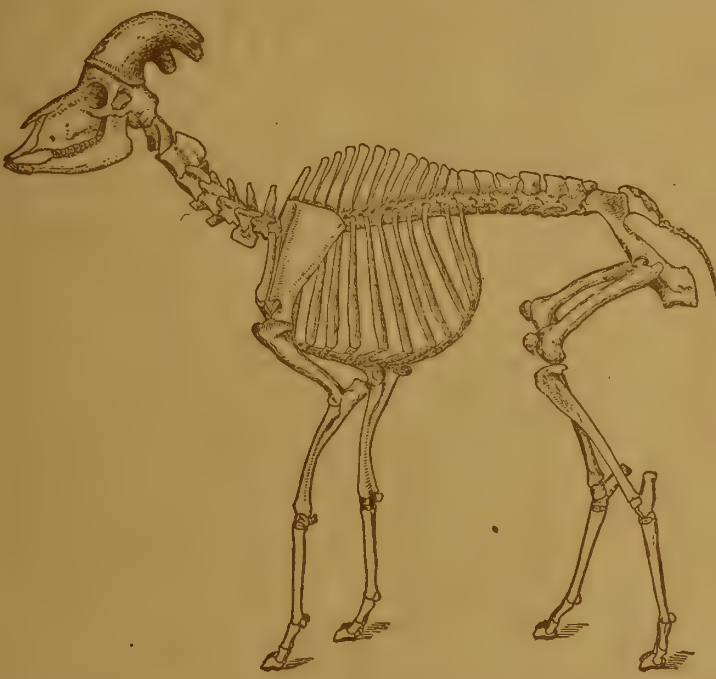
Unless there are special reasons to be considered to the contrary, the first specimens of any species will always be preserved as skins. Afterwards, if the skeleton is believed to

Fig. 25. Rough skeleton of a francolin, dried and bundled together for packing. The tag is of thin wood, bearing a number written with soft lead pencil.

offer points of interest, a few adult specimens, which have not many of their bones injured, may be prepared as skeletons. It has already been explained, however, that small birds, even though desired for their skeletons, are best sent home preserved in alcohol or formalin. Such specimens are also of great value for the study of the soft anatomy, and of the arrangement of feather tracts.

THE AMERICAN MUSEUM OF NATURAL HISTORY

THE PREPARATION OF ROUGH SKELETONS



By FREDERIC A. LUCAS

GUIDE LEAFLET SERIES, No. 59

NOTE

This leaflet is one of a series intended to furnish accurate information in regard to the preparation of specimens of various kinds for Museum purposes.

The following have been issued and may be purchased at the sales booth or from the Librarian; others are in the course of preparation:

The Preparation of Birds for Study
By James P. Chapin. Price 15 cents

How to Collect and Preserve Insects
By Frank E. Lutz. Price 10 cents

Suggestions to Collectors of Reptiles and Amphibians
May be had on application to the Curator, Dept. of Herpetology

THE PREPARATION OF ROUGH SKELETONS

By Frederic A. Lucas

INTRODUCTORY

Why Skeletons are Needed

The skeleton is the best, and most enduring evidence we have, of any animal's place in nature and its relationships with other animals: it is also the solution of a problem in mechanics, that of carrying a given weight and of adaptation to some particular mode of life. So the skeleton not only indicates the group of animals to which its owner belongs, but also tells of his mode of life, for it varies, or is modified, according as a creature dwells on land, lives underground, or in the water, walks, swims or flies; feeds on grass, catches insects, or preys upon its fellows. Skeletons, therefore, are not only necessary for the student of the life of to-day, but to the palæontologist, for the life of the past can only be interpreted by comparison with that of the present; also the modern taxidermist needs the skeleton to aid him in the proper mounting of animals, especially mammals.

It is not always convenient or even practicable to collect skeletons, especially of large animals, and in such cases skulls are always welcome; this is particularly true of such large reptiles as crocodiles and turtles.

These directions for preparing rough skeletons, based on twenty years experience, were drawn up some thirty years ago and printed as one of a series of instructions for collectors issued by the U. S. National Museum. They are now, by permission, reprinted here with a few trifling changes. They have been divided into sections, in order that the collector might turn at once to the portion bearing directly on the

subject in hand. The general directions for mammals, however, apply with more or less force to all skeletons.

The extent to which these instructions can be followed will of necessity depend largely on circumstances. It is not to be expected that a collector working in the field would use the same time and care as one residing on the spot or located for some time at one place, but as one well prepared, *perfect* skeleton is worth more than half a dozen mutilated specimens, a little time spent in the work of roughing out and packing will be well repaid.

Identification of Specimens

It is, of course, extremely important to know the correct name of every skeleton, and whenever possible this should be attached to the specimen, but it is a mere waste of valuable time to endeavor to identify specimens in the field.

When the animal is unknown, its skin, roughly taken off, should be kept, or the skin of another specimen should be prepared in the usual manner, in order that it may serve as a means of identifying the skeleton.

Labeling

The best method is to have a series of numbers, stamped on pure sheet tin, and provided with a string for tying them to specimens, the numbers being recorded in a notebook.

Unfortunately these tin numbers are not always to be had, and a very good substitute may be made by cutting Roman numbers on a block of wood, or even notches on a stick.

If labels are used let them be of good stout manila, as thin paper is apt to be torn or defaced.

Do not use wire of any kind to fasten tin or lead numbers to specimens that are to go in alcohol or brine, for this sets up a galvanic action which results disastrously.

Selection of Specimens—Fractures

Where time allows, select a series of skeletons of different ages; but where only one skeleton can be prepared, choose a fully grown, adult animal, as free as possible from fractures. If an animal is shot or trapped it is impossible to avoid breaking some bones, and such must be allowed to pass, but where it has been beaten to death, fracturing the skull and limb bones generally, the animal had better be thrown away at once.

If the skull alone is broken, select if possible another of the same size and send *both* with the body. When convenient send with a broken leg or wing another of the same size, but on no account throw away the fractured limb.

Do not neglect any animal simply because it is common, for a common species may be anatomically important.

Tools

A knife and a pair of scissors are all that are absolutely necessary, but if these can be supplemented by one or two steel scrapers, the work will be greatly facilitated.

"Roughing Out"—Mammals

If an animal is rare, the skin should be very carefully taken off and preserved; otherwise, remove the skin roughly and disembowel the specimen, taking care not to cut into the breastbone, especially the disk-shaped piece of cartilage in which it ends. Animals destined for skeletons should *on no account* be split up the breast as though they were being dressed for market.

Detach the legs from the body and remove the flesh, taking care in so doing not to remove the collar bone or kneepan with the meat. In the cat family the collar bone is very small, and lies loose in flesh between the shoulder blade and front end of the breastbone. The collar bone of weasels is

very minute and difficult to find, while, on the other hand, climbing and burrowing animals usually have this bone well developed, uniting the shoulder blade with the breastbone.

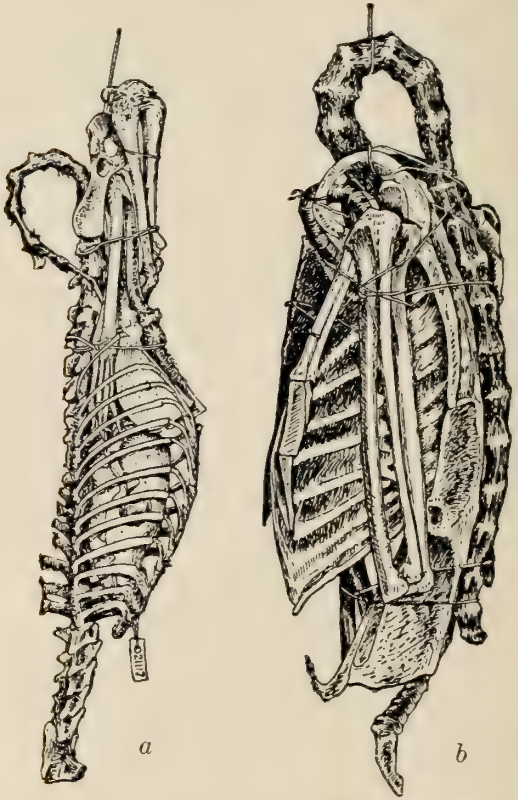


Fig. 1.—*a*, **Skeleton of Fox ready for packing.**
b, **Skeleton of a bird ready for packing.**

Deer, antelopes, bears, and seals have no collar bone.

In small quadrupeds it will be unnecessary to detach the legs, but, whenever convenience in roughing out or packing

renders this needful, cut the collar bone loose from the breastbone and leave it fastened to the shoulder blade.

The legs being finished, disjoint and clean the skull. Be careful in removing the eyes not to thrust the point of the knife through the thin portion of the skull back of them and in deer, antelopes, or other ruminants, take care not to break through the thin bone back of the upper teeth. Also be careful not to cut off any projections of bone.

Remove as much of the brain as possible with a scraper, bent wire, or small stick.

In cleaning the ribs take care not to cut the cartilages joining them to the breastbone, and, when the tail is reached, look for a few little bones projecting downwards from the first few vertebræ.

Fold the legs snugly along the body, or, if they have been detached, tie them together with the skull on the under side, as much as possible within the chest cavity; also turn down the tail and tie it upon itself. See cut on page 4.

Roll up in a bit of rag and fasten *securely* to one of the long bones any bones which may have been detached or any splinters from a broken bone.

Hang the skeleton to dry in the shade, where it will escape dogs, cats, and rats. In this as in many other particulars the collector will necessarily be governed by circumstances, for in moist climates, or on shipboard, it may be needful to dry specimens in the sun, or even by the aid of a fire.

Lastly, in case a small skeleton is likely to be some time on the road, give it a very thin coat of arsenical soap to preserve it from the attacks of Dermestes and other insects.

On *short* collecting trips the poisoning may be omitted and the specimens treated when they reach their destination, but where small skeletons are to lie for some time uncared for, they should be poisoned, otherwise they may arrive in a very much mixed and dilapidated condition.

The breastbones of large animals should also be well poisoned.

The *best* method of poisoning small specimens is to dissolve arsenic in hot water, and when the solution is cold soak the skeletons in it for an hour or so. All the small rough skeletons stored in museum collections, as well as those in the stock of dealers in natural history material, are or should be thus

Fig. 2.—**Tongue bones or hyoid of a Dog.**
Fig. 3.—**Right shoulder blade of a Rabbit.**
Showing the backwardly projecting process.

treated. The addition of a little washing soda will cause water to take up much more arsenic than it otherwise would.

Should any of these small specimens be needed for disarticulated skeletons the arsenic can be extracted by soaking in a hot solution of washing soda.

Special Points

Embracing the upper part of the windpipe and connecting it with the base of the skull is a series of bones known as the hyoid apparatus. This should be carefully saved. See cut.

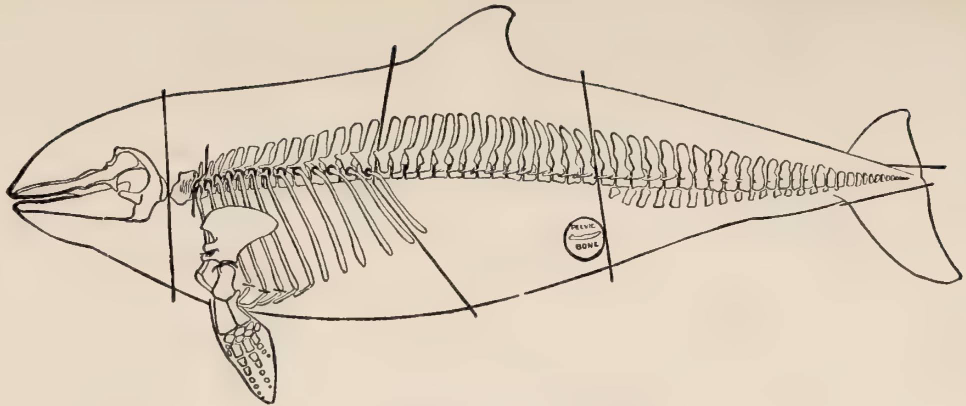


Fig. 4. **Skeleton of a Porpoise.**
The lines show where the cuts should be made in dividing the skeleton

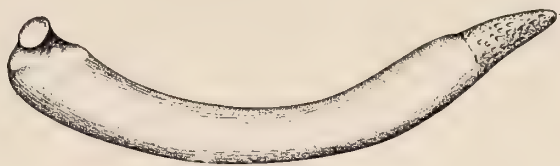


Fig. 5.—**Pelvic bone, natural size of a Porpoise (Tursiops).**

There are usually small bones, termed sesamoids, embedded in the tendons, where they play over the under sides of the toes, and on this account the tendons should never be cut off close to the bone.

There are often one or two small bones on the back lower portion of the thigh bone; these should be left in place.

In preparing the skeletons of rabbits particular attention should be given to the shoulder blade, as this has a slender projection at the lower end, which extends some distance backward. See cut on page 6.

The male organ of a great many quadrupeds, as the raccoon, is provided with a bone. As it is difficult to say when this may or may not be present, it should always be looked for, and when found left attached to the hip bones.

Cetaceans: Porpoises, Blackfish, Etc.

Porpoise skeletons are very easily prepared, but one or two points, such as the slender cheek bones and the pelvic bones or rudimentary hind limbs, require special care.

The pelvic bones are so small and so deeply imbedded in the flesh that they are only too often thrown away. The accompanying cuts show their location and their average size in a specimen 7 or 8 feet long. See cut on page 7.

It often happens that the last rib lies loose in the flesh, with its upper end several inches from the backbone. This should always be looked for.

There are no bones in the *sides* of the tail or flukes nor in the back fin, and they can be cut off close to the body and thrown away.

The hyoid is largely developed in most cetaceans, and will be found firmly attached to the base of the skull.

Birds

In preparing a bird for a skeleton a little more care must be used than is necessary with a quadruped, the bones being lighter and more easily cut or broken.

The wings terminate in very small, pointed bones, and there is a similar bone—corresponding to the thumb of mammals—hidden in a tuft of feathers on the bend of the wing.

It is a good plan to leave this tuft untouched, as well as the outermost two or three wing feathers, so as to lessen the risk of removing any of these little bones with the skin.

Other parts requiring special attention are the slender points on the under side of the neck vertebræ, those projecting backward from the ribs, and the last bone of the tail.

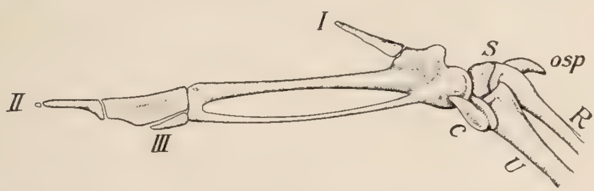


Fig. 6.—**Portion of right wing of Great Horned Owl.** Seen from below. *R*. Radius; *U*, Ulna; *I*, *II*, *III*, First, second, and third fingers; *s*, Radiale; *c*, Ulnare; *osp*. Os prominens.

It frequently occurs in birds that many of the tendons become ossified, as they do in the leg of a turkey. Look out for such on the under side of the neck, in the legs and wings, and along the sides of the back, and do not tear off the muscles as you would if preparing a skin.

In many, possibly most birds, the neck and back can be left untouched, as the muscles will dry up and a thin coat of arsenical soap will serve to keep out the Dermestes which would otherwise attack these places.

The hyoid bones, which support the tongue and are attached to the windpipe, should be saved, as should also the windpipe itself whenever, as in many ducks, it has bony structures developed in part of its length. See page 10.

In many birds, and especially in birds of prey, there is a ring of bones surrounding the pupil of the eye. It is there-

fore best—unless you are an expert—not to remove the eyeball, but to simply puncture it to allow the escape of its fluid contents.

Remove the brain carefully.

In making the skeleton into a bundle for packing, bend the neck backward, detaching the skull if necessary, and fold the legs and wings closely alongside of the body. See page 4.

Special Points

Cormorants have a small bone attached to the back of the skull, and in Auks and many similar birds there is a small bone at the elbow.

Fig. 7.—**Tongue bones or hyoid of a Great Blue Heron.**
Fig. 8.—**Eye-bones, sclerotals, of a Great Blue Heron.**

Sometimes there is a little bone at the hinder angle of the lower jaw, so that it is a good rule not to trim up a bird's skull too closely.

The easiest, and in many ways best, way to collect small birds is to place them entire in alcohol first making an incision in the lower part of the abdomen to allow the alcohol to reach the viscera.

Alcohol should not be used of full strength (95°), the proper proportion being one-quarter water and three-quarters alcohol. Not only birds, but small mammals and reptiles, may be preserved entire in alcohol, but now-a-days this cannot always be procured. Aside from the cost it is becoming increasingly difficult to obtain alcohol, even methylated spirit, and the demand for rum has rendered its use almost prohibitive.

Formalin was not in use when these instructions were written; it is a convenient medium for the preservation of small animals, especially where the soft parts are desired, but if animals are left in a solution of formalin for any length of time the bones are decalcified, lose their mineral matter, and become more or less useless. Unfortunately it often happens that nothing else is available, but if you must use formalin use it weak, in the proportion of one part of formalin to twelve of water.

Turtles

In order to rough out a turtle it is usually necessary to remove the under shell or plastron, although some species, such as certain of the large land tortoises, can be roughed out without doing this.

In sea turtles and a few others the plastron can be cut loose by taking a little time to the operation, but in the more solidly built tortoises and most fresh-water turtles it is necessary to saw through the bone, following the line indicated in the accompanying diagram.

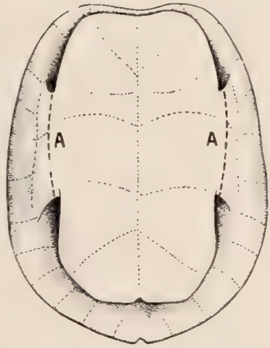


Fig. 9.—**Shell of a turtle (Chrysemys marginata).**

A A, where cuts should be made to remove the lower shell or plastron.

The interior of the body being exposed, it is a comparatively easy matter to cut away the flesh.

Usually this can be done without disjointing any of the legs, and it is better, especially in small specimens, to leave them attached to the body. Beware, however, of cutting into any bones, as they are frequently soft in texture and easily damaged.

Snakes

Snakes require very little care in their preparation after the skin has been removed, but in the larger serpents, such as boas and pythons, rudimentary hind legs are present and should be carefully preserved.

Externally the legs appear as two little claws situated on either side of the vent; internally they are slender bones, about an inch and a half in length, loosely attached to the ribs.

Fig. 10.—**Limb of a Python (Python molurus), full size.**

It is a comparatively easy matter to preserve both the skin and skeleton of any good-sized snake by exercising a little patience.

Do not try to skin through the mouth, but make a long cut on the under side and skin either way from it.

Coil up the skeleton and it will make a very compact bundle.

Crocodiles

The breastbone of crocodiles extends the entire length of the body, and although the hinder portion of it is not attached to the backbone, yet great care is necessary in disemboweling not to cut away any of the slender bones of which it is formed.

There are also cartilaginous projections on the ribs which should not be sliced off in roughing them out.

Fishes

Fishes vary so much in their structure that it is a difficult matter to give any directions for preparing their skeletons that would be of much service. As a rule species of small or moderate size are preserved entire in alcohol or formalin and only the larger species "roughed out." Almost invariably there are two rows of ribs present, and these extend backward for some distance.

Proceed slowly and carefully, as the edge of the scalpel will often give notice of some unsuspected bone.

Be especially careful about the head. There is a chain of bones encircling the eye, and the eyball itself is often a bony cup.

Occasionally there are two or three bones attached to the back part of the hinder portion of the head, and the patch of flesh on the cheek is about all that can safely be removed.

When the skeleton is hung up to dry place bits of wood or other material between the gills so that the air may circulate freely and dry them rapidly.

Fishes, small reptiles, and toads and frogs can be best collected by placing them in alcohol.

Packing

First be sure that a skeleton, and especially a small one, is thoroughly dry. Otherwise it is apt to "sweat" and rot the ligaments.

In the case of a large skeleton this would do no harm, but as the bones of small animals are left attached to one another by their ligaments and are not wired together, any such separation causes serious injury.

If the specimen is the size of a deer, it will be necessary to disjoint the backbone just behind the ribs in order to make a compact bundle.

A moose or buffalo can be cut up still more by separating the leg-bones at each joint and making several sections of the backbone.

Occasionally it is necessary to reduce a skeleton to its smallest possible dimensions, and then, in addition to the above measures, the breast-bone must be separated from the ribs by cutting through the cartilage *just below the end of each rib.* The ribs can then be detached from the backbone, and thus dismantled a good-sized skeleton can be packed in a flour barrel. Barrels, it may be remarked, are very useful for pack-

ing purposes. It is a good plan to wrap a rag, a little tow or something around the front teeth of deer and similar animals to prevent the incisors from chipping while in transit and if

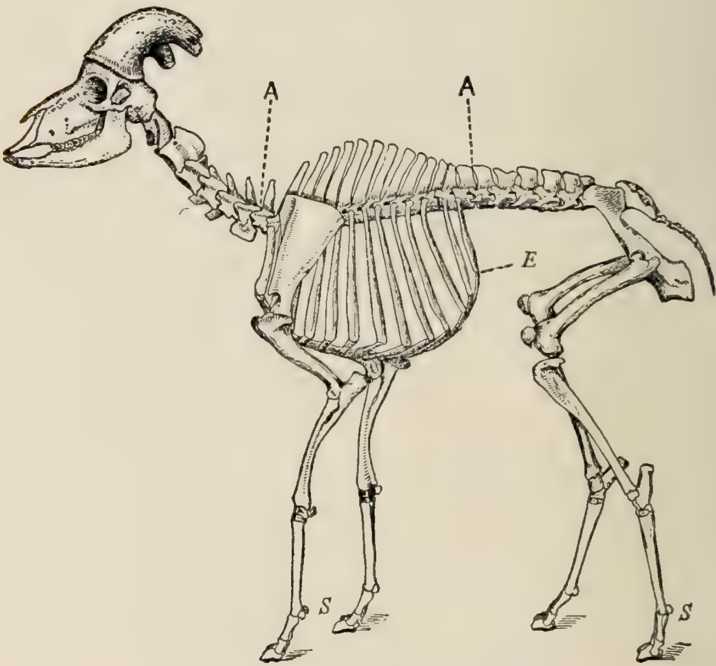


Fig. 11.—**Skeleton of Mountain Sheep.**
AA, places where backbone may be disjointed; E, place where cut should be made to separate rib from breast-bone; S, sesamoids.

you are very careful you will put something between the grinding teeth for the same purpose.

Boxes should be tight, so as to shut out hungry dogs and prevent entirely the attacks of rats and mice. I have frequently seen valuable skeletons that were ruined in a single night by ravages of one or two rats.

Care should also be taken not to leave boxes open over night while being packed, lest mice should make a nest in the packing material and be shut up with the specimens.

Straw or hay is the best packing material, but Spanish moss, shavings, "excelsior," or cocoa fiber will serve the purpose. Usually but little is needed, the main point being to prevent the skeletons or loose bones from rattling about.

Beware of sea weed for packing. No matter how dry it appears to be, it contains so much salt as to become wet when exposed to a moist atmosphere.

Never put alum on a skeleton, nor soak any bones in a solution containing alum.

In hot, moist climates it is occasionally allowable to sprinkle a little salt on the bones of a large animal in order to keep the flesh from putrefying instead of drying. Some aquatic animals, such as seals and porpoises, can be packed in salt without detriment to their bones, a fact that is often of great advantage when such animals are collected on shipboard, where it is often difficult or even impossible to dry large skeletons.

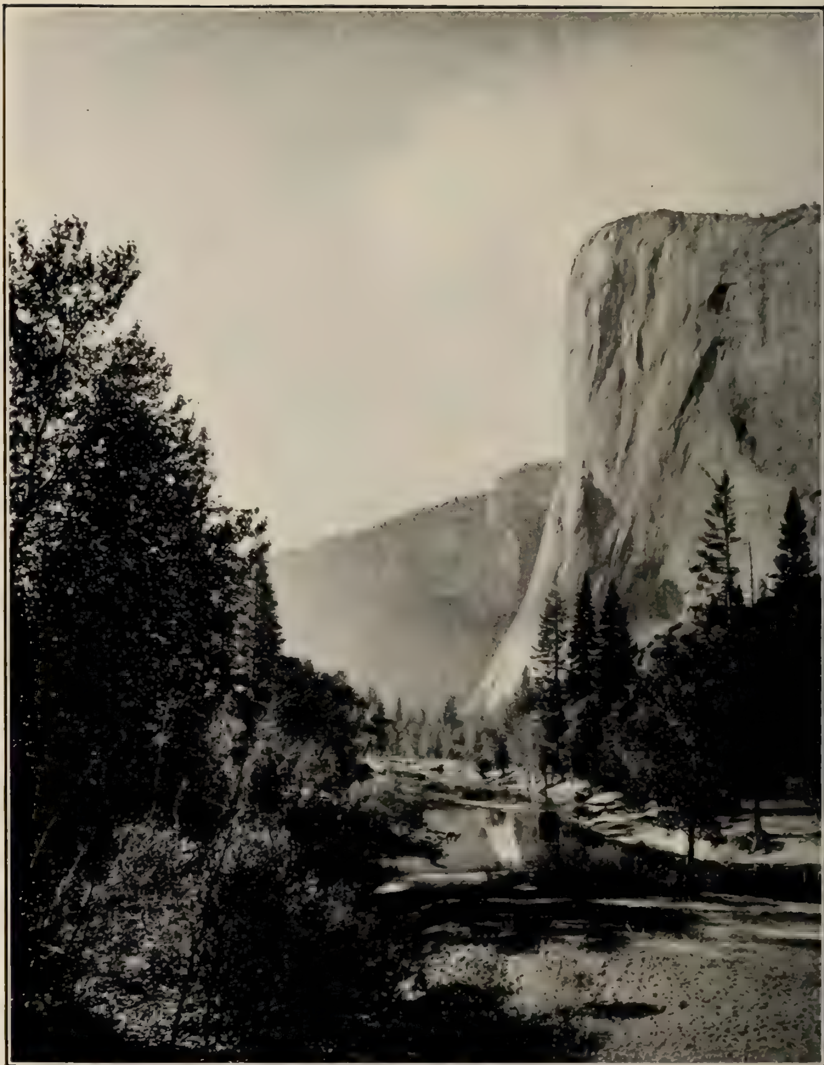
Small skeletons should on no account be salted, nor should large ones be boiled to remove the flesh.

THE AMERICAN MUSEUM OF NATURAL HISTORY

THE STORY OF THE YOSEMITE VALLEY

By FRANÇOIS E. MATTHES, Ph. D.

GUIDE LEAFLET No. 60



J. K. Hillers Pho

El Capitan, the noblest cliff in Yosemite Valley

The view shows the bold profile of the 3,000-foot cliff as it appears from the ea at a distance of one and a half miles. Beyond El Capitan are the lesser cliffs that flan the recess of the Ribbon Falls.

THE STORY OF THE YOSEMITE VALLEY

By FRANÇOIS E. MATTHES, Ph. D.

American Museum of Natural History
Guide Leaflet No. 60
New York, July, 1924

The model of the Yosemite Valley and vicinity is one of a series of fifteen relief models of geologically important areas of the United States, representing the existing topography surface of the areas chosen. The hard-rock or underlying geology is represented by colors and patterns taken from the rocks themselves, except in the Watkins Glen-Seneca Lake and the Niagara Falls models, where the superficial Glacial deposits are shown, and in the Porto Rico model, where the scale of the map is too small to permit such treatment. The painted background of each model represents the present day scenery of the surrounding country, and the sky depicts different meteorological conditions as far as practicable.

With the exception of the Yosemite Valley and the Mount Washington models the subjects of these models and their location in the hall were suggested by Associate Curator C. A. Reeds. The construction of all the models has been done under the direction of Curator E. O. Hovey, except that the core of the Grand Canyon model was begun by Doctor Reeds. The cores of the models have been built at the Museum and have been based on the topographic sheets issued by the United States Geological Survey, and the United States Coast and Geodetic Survey, except for Porto Rico, based upon a compilation by C. A. Reeds, and Mount Washington, based upon the maps by the State of New Hampshire and the Appalachian Mountain Club. The modeling and painting have been done by Lester Morgan of Morgan Brothers, following published geological maps of the regions and photographs from several sources. In the Yosemite Valley model the geology has been represented according to unpublished maps and other data furnished by the U. S. Geological Survey.

THE STORY OF THE YOSEMITE VALLEY[1]

By François E. Matthes, Ph.D.

UNITED STATES GEOLOGICAL SURVEY

If you should start from San Francisco in an airplane and fly due east you would pass first over the wooded crests of the Coast Ranges; next over the broad, level expanse of the Great Valley of California, checkered with irrigated fields, vineyards, and orchards; and then, after a flight of about a hundred miles, you would come to a huge mountain barrier, stretching north and south at right angles to your course and rising in a long, gradual slope to a resplendent row of snow-flecked peaks. This is the Sierra Nevada, the longest, the highest, and the grandest single mountain range in the United States.

Deeply carved in its western flank, about midway between the torrid foothills and the wintry summits, in the genial middle zone of majestic forests, you would discover the Yosemite Valley, the chasm that has become renowned the world over for its towering cliffs, its stately trees, and its delightful climate, but, above all, for its sublime waterfalls. If "Yellowstone" spells "geysers," "Yosemite" spells "waterfalls."

As you fly over the valley you may at first be surprised to find that it is no larger. It measures only 7 miles in length and 1 mile in width and is really but a widened part of a narrow canyon that furrows the range from crest to base,—the canyon of Merced River. Indeed, the valley is only one of a great many features—though by far the most wonderful—of the Yosemite National Park, which embraces a part of the western flank of the

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[1]Guide Leaflet No. 59 of the American Museum series.—Text kindly furnished through the courtesy of the United States Geological Survey.

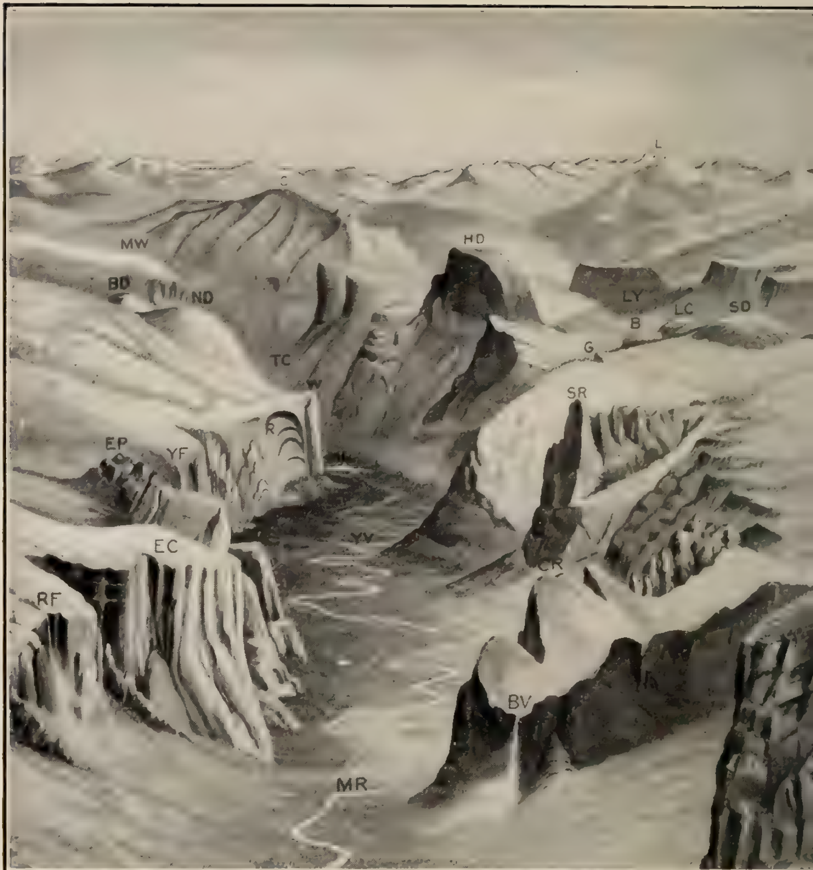


Fig. 1. Bird's eye view of Yosemite Valley and the High Sierra beyond

R F	Ribbon Falls.	N D	North Dome.	B	Mount Broderick
E C	El Capitan.	B D	Basket Dome.	G	Glacier Point.
E P	Eagle Peak.	M W	Mount Watkins.	S D	Sentinel Dome.
Y F	Yosemite Falls.	C	Clouds Rest.	S R	Sentinel Rock.
R	Royal Arches.	H D	Half Dome.	C R	Cathedral Rocks.
W	Washington Column.	L	Mount Lyell.	B V	Bridal Veil Falls.
M	Mirror Lake.	L Y	Little Yosemite.	Y V	Yosemite Village.
T C	Tenaya Canyon.	L C	Liberty Cap.	M R	Merced River.

Sierra Nevada almost as large as the State of Rhode Island, that is studded with peaks, domes, and spires and sculptured by valleys, gorges, and canyons. Among the canyons is the Grand Canyon of Tuolumne River, which lies 12 miles north of the Merced Canyon and parallel to it and which also has a Yosemite-like widened part—the beautiful Hetch Hetchy Valley.

But when finally you descend into the Yosemite you at once perceive the reason for its world-wide fame. No other valley is so remarkably fashioned; no other valley holds within so small a compass so astounding a wealth of striking and distinctive scenic features. As a whole, it is a broad rock-hewn trough with parallel sides, boldly sculptured and ornamented with silvery cataracts. The level floor, whose groves and meadows afford ideal places for camping and other forms of recreation, lies 4,000 feet above the sea, and the forested uplands on either side rise 3,000 to 4,000 feet higher.

As you look eastward up the valley from its lower end your eye is at once attracted by the sheer profile of El Capitan, the most majestic cliff in the Yosemite and perhaps in the world. It projects from the north wall, its top fully 3,000 feet above the valley floor. Directly opposite stand the three Cathedral Rocks, of nearly equal height, which form the only promontory that juts far out into the valley. From the west end of this promontory leaps the Bridal-Veil Falls, 620 feet in height, its spray suffused with the glory of the rainbow.

Eastward beyond El Capitan and the Cathedral Rocks the valley abruptly regains its full width, and you behold in an embayment on the right the two Cathedral Spires, the frailest rock shafts in the valley. On the left are the Three Brothers, whose gabled summits rise one above another, all built on the same angle, as if designed

by an architect. The highest, known as Eagle Peak, rises 3,800 feet above the valley. Opposite them stands Sentinel Rock, a finely modeled obelisk with a pointed top.

BRIDAL VEIL FALLS
620 feet high

A mile beyond the base of Sentinel Rock nestles Yosemite Village, the main tourist center of the park, and just across the valley, booming amid clouds of pearly

F. E. Matthes, Photo

YOSEMITE FALLS, FROM THE BANKS OF MERCED RIVER

The upper fall, 1,430 feet in height, is probably the highest fall of its kind in the world. The lower fall is 320 feet high, and the total descent of the water from the brink of the upland to the floor of the valley is 2,565 feet. The lower fall as seen above is three-fourths of a mile from the camera; the upper fall is nearly one and a half miles distant.

mist, are the Yosemite Falls, most glorious of all the cataracts in the valley. The upper fall, 1,430 feet high, would alone make any valley famous—it is the highest unbroken leap of water on the continent, perhaps the highest in the world. The lower fall, which descends 320 feet, seems insignificant in comparison, yet it is twice as high as Niagara. The entire chain of falls and cascades has a height of 2,565 feet.

Farther up, on the north side, are the Royal Arches, sculptured one within another in an inclined rock wall that rises to a height of 1,500 feet. An enormous natural pillar, the Washington Column, flanks them on the right, and above them rises a smoothly curving, helmet-shaped boss of granite called North Dome.

Facing the Royal Arches, on the south side, is Glacier Point, a high promontory that has become a veritable Mecca for tourists by reason of its matchless view and its unique overhanging rock, below which the cliffs fall off sheer 3,200 feet.

The head of the valley is squared off by another rock wall, and above that wall, planted as on a pedestal, stands Half Dome, the most colossal and most strangely modeled rock monument in the Sierra Nevada, smoothly rounded on three sides and cut down sheer on the fourth, like an apple sliced in two. Though it has been inaccessible heretofore, owing to the smoothness of its sides, it may now be easily scaled with the aid of steel cables so hung as to serve as hand rails.

From the summit of Half Dome, 4,850 feet above the valley, you look down, on the south side, into the Little Yosemite, a broad-floored, cliff-girt valley shaped like the Yosemite, though much smaller. It lies at a level 2,000 feet above the main valley, and from its portal, guarded by Liberty Cap, the Merced descends by a cyclopean stairway, making two magnificent cataracts,

the Nevada Falls, 594 feet high, and the Vernal Falls, 317 feet high.

On the north side of Half Dome you look down into Tenaya Canyon, a chasm as profound as the Yosemite itself, yet the pathway of only a small tributary brook. Almost directly under Half Dome, at the canyon's mouth, lies romantic Mirror Lake. To the northeast Clouds Rest, the loftiest summit in the vicinity of the valley, rises 9,929 feet above the sea, and beyond spreads the vast panorama of the High Sierra, its jagged peaks culminating in ice-covered Mount Lyell, at a height of 13,090 feet.

And now, filled with wonder at the marvels of this stupendous scene, you may feel impelled to ask: How was all this created? By what strange forces has the Yosemite been fashioned, and through what happy circumstances has it become endowed with so much charm and grandeur?

This, then, is the story of the Yosemite: Millions of years ago—about at the end of what geologists call the Cretaceous period—all the country reaching from the Pacific coast to the Rocky Mountains began to bulge up as a result of disturbances in the interior of the earth. The movement was slow and intermittent, yet it caused the crust of the earth to be rent by long fractures, or "faults," as they are called by geologists, and broke it into huge blocks that crowded against and slipped on one another. Some of these blocks were gradually forced up and more or less tilted, so that they began to stand out as mountain ranges; other blocks remained low or were depressed and formed valleys and basins. Thus originated the multitude of roughly parallel northward and northwestward trending ranges and intermediate desert basins of western Utah, Nevada, and eastern California.

The westernmost and largest block, 400 miles long and 80 miles broad, was destined to become the Sierra Nevada. It early acquired a feeble slant to the west, its eastern edge being pushed up and its western edge

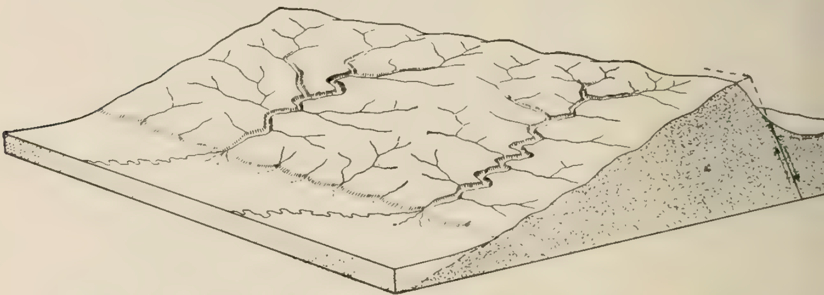


FIG. 2 GENERALIZED DIAGRAM OF A PART OF THE TILTED SIERRA BLOCK

The break, or "fault," that separated it from the next block to the east is shown by a heavy line, and the directions in which the blocks have slipped past each other are shown by arrows. The height and slant of the Sierra block are much exaggerated. In front of the range is a strip of the Great Valley of California, which is underlain by many layers of sand and silt washed down by streams. At the back of the range is a strip of Owens Valley, likewise covered with sediment. The main rivers on the Sierra block have arranged themselves roughly parallel to one another, in the direction of the western slopes, but their lesser tributaries continue to be guided by the irregularities on the surface and flow in diverse directions. The main rivers, having been accelerated by the tilting, have carved deep canyons, but many of their tributaries, and especially those that flow at right angles to the direction of the tilting, have not yet intrenched themselves and still drop into the canyons from "hanging valleys." The conditions shown correspond in a general way to those that prevailed for some time after the first great uplift mentioned in the text.

pulled down. After a great lapse of time—in the latter half of the Tertiary period—the slant of the block was steepened and the eastern edge was raised to a mountain crest several thousand feet high. Still later, about the dawn of the Quaternary period—the last great

division of geologic time, which embraced the Ice Age and witnessed the rise of man—a series of thrusts more vigorous than any that had preceded it tilted the Sierra block still more strongly and lifted it to its present great height—to altitudes ranging from 7,000 feet at the north to more than 14,000 feet at the south.

One effect of the tilting was, naturally, to bring about a rearrangement of the waters on the surface of the

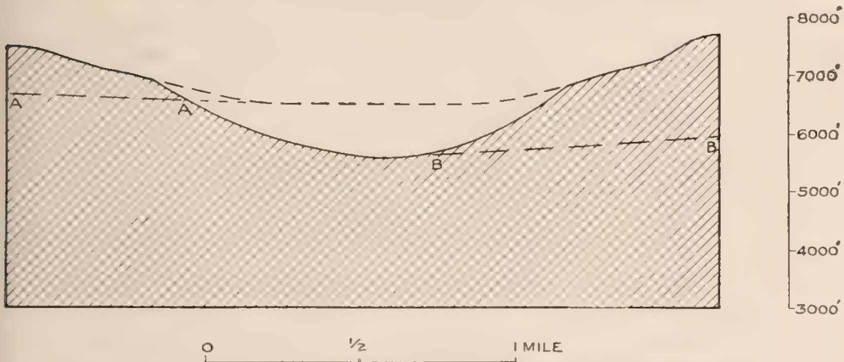


FIG. 3. SECTION OF THE "TWO-STORY VALLEY" WHICH THE MERCED HAD CUT BY THE END OF THE TERTIARY PERIOD.

A–A is the profile of a side stream which was unable to trench as rapidly as the Merced and whose valley has therefore remained "hanging." B–B is the profile of a side stream that succeeded in "catching up" with the trenching of the river. This diagram and the two following are drawn to scale and represent the successive stages in the development of the Yosemite Valley in their true proportions.

Sierra block. The main streams originally flowed in diverse directions, but when, early in the Tertiary period, the Sierra block acquired a considerable slant, they changed their courses and began to flow in the direction of the slant. A series of parallel rivers thus came into existence, all heading at the eastern edge and draining westward, into the Pacific Ocean. The Merced was one of these new rivers.

In the long period of quiet that followed the earlier tiltings the Merced fashioned for itself a broad, level valley, through which it wound sluggishly in serpentine meanders. The valley was flanked as far up as the site of the present Yosemite chasm by rolling hills and occasional ridges a few hundred to a thousand feet in height, all covered with luxuriant semitropical vegetation. The rounded summit of El Capitan was one of the rolling

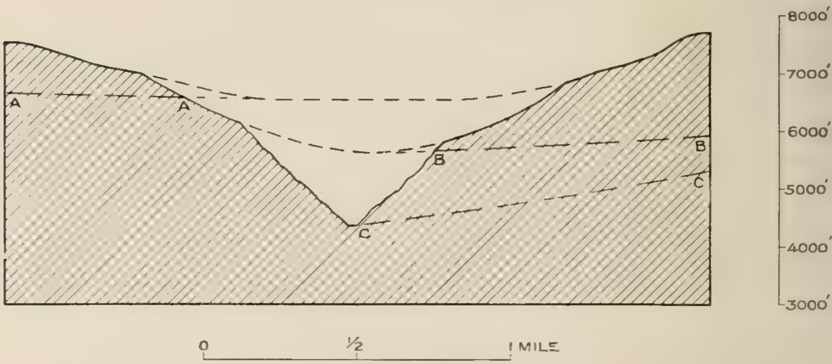


FIG. 4. SECTION OF THE "THREE-STORY CANYON" WHICH THE MERCED OCCUPIED EARLY IN THE QUARTERNARY PERIOD, JUST BEFORE THE ONCOMING OF THE ICE AGE.

The river has cut its inner gorges so rapidly that now the valley of the stream B–B also is left "hanging." But a third stream C–C, more favored than the others because the rock in its path is unresistant, has succeeded in keeping pace with the trenching of the river.

hills; it rose about 900 feet above the Merced. Toward the headwaters of the river the land was more mountainous, but the region as a whole still lay near sea level.

The great uplift of late Tertiary time, which raised the Sierra block to a height of several thousand feet, affected the behavior of the Merced profoundly. The course of the stream now being much steeper than before, its flow became swift and powerful, and, with the sand,

gravel, and boulders that it swept along, it began vigorously to scour and deepen its bed. As time went on it cut in the broad floor of its old valley a narrow, steep-walled gorge—a "gorge within a valley." Although it cut ever more and more slowly as its gradient became flatter and flatter, toward the end of the Tertiary period

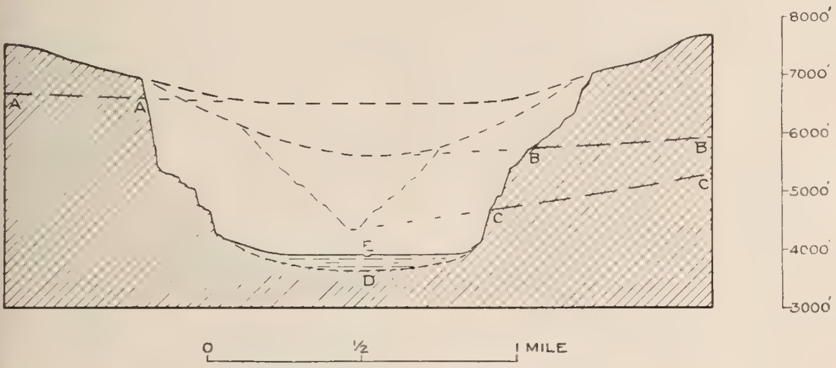


FIG. 5. SECTION OF THE BROAD, STEEP-SIDED YOSEMITE TROUGH AS IT IS TO-DAY.

The transformation from the original "three-story canyon" was accomplished mainly by the quarrying action of the glaciers of the Ice Age. The floor of the glacial trough is at D. The present valley floor is at E, and D–E is the depth of the basin of ancient Lake Yosemite, which now is filled with river-borne sediment. As a result of further deepening of the chasm and of its widening by the ice the valley of the stream C–C now also "hangs," so that there are three sets of "hanging valleys" at different levels, one above another, all having waterfalls pouring from their mouths.

the river had intrenched itself nearly a thousand feet. The gorge, however, had been transformed by that time, through the crumbling of its walls, into a valley with sloping sides, and so the river lay at the bottom of a "valley within a valley"—or a "two-story valley"—such as is outlined in Figure 3.

The side streams were at first unable to trench as rapidly as the Merced. They had smaller volume and therefore less cutting power, and a number of them were handicapped by following courses that lay at right angles to the general course of the river and therefore at right angles to the slope of the Sierra block. These streams were not steepened by the tilting and continued to flow as leisurely as before. As the river cut its gorge deeper and deeper, therefore, the side valleys remained "hanging" at greater and greater heights. They were transformed into what are properly termed "hanging valleys." But later, as the master stream's gradient became flatter and its cutting power waned, most of the side streams by degrees "caught up" with its trenching and the hanging valleys were destroyed—all but a few in the Yosemite region that were underlain by exceedingly resistant, massive granite. These few remained almost untouched and so, at the end of the Tertiary period, the Yosemite was left with several hanging side valleys from whose lips foaming cascades poured. Yosemite Creek, which now produces the great Yosemite Falls, then made a broken cascade 600 feet high. Bridal Veil Creek and Sentinel Creek each cascaded down a vertical distance of 900 feet; Meadow Brook 1,200 feet; Ribbon Creek 1,400 feet.

The last and greatest uplift of the Sierra Nevada, which occurred about the beginning of the Quaternary period, again accelerated the Merced to the swiftness of a mountain torrent—indeed, it gave that stream greater velocity and cutting power than it had ever possessed. What is more, the greatly increased height of the range brought with it a marked change in climate. Deep snows fell on the crest in winter, and the rapid melting of these snows in spring produced freshets of tremendous volume and correspondingly great destruc-

tive power. Thus the river again intrenched itself and with greater rapidity than before carved a new inner gorge, thus producing a "three-story canyon" such as is outlined in Figure 4. In this new inner gorge the river still flows from the lower end of the Yosemite to the foothills. At El Portal, the main gate to the Yosemite National Park, the gorge attains its greatest depth—about 2,000 feet—and the three-story canyon as a whole has a depth of about 3,500 feet.

As happened after the preceding uplift, so after the last, the side streams, and especially those running at right angles to the direction of the tilting, were unable to trench as rapidly as the master stream. And so the new gorge came to have a number of hanging side valleys, and the Yosemite, which already possessed one set of hanging valleys, acquired a second, lower set. To this lower set belong the valleys of Indian Creek and Illilouette Creek. Both of them, as well as some of the hanging side valleys of the lower Merced Canyon, are to-day still well preserved, although they are underlain by less resistant rocks than the older and higher hanging valleys of the Yosemite region. Indeed, so short a period of time, in a geologic sense, has elapsed since the last uplift that only a few of the larger and more favorably situated side streams have succeeded thus far in "catching up" with the trenching of the master stream.

Among these more successful streams are two tributaries of the Yosemite Valley—Tenaya Creek and Bridal Veil Creek. Tenaya Creek had the double advantage of a southwesterly course, following the direction of the tilting, and of being underlain by closely fractured rock and was thus able to trench deeply. Bridal Veil Creek, less advantageously situated, carved only a short, steeply descending gulch—the gulch that now ends abruptly at the precipice of the Bridal Veil Fall. That

cataract, however, was not yet in existence, for the gulch led directly to the bottom of the main chasm. The present lip of the gulch at the top of the waterfall, it is believed, still indicates roughly the level at which the Merced lay in early Quaternary time—that is, just prior to the first great extension of the glaciers of the Ice Age. Evidently the Yosemite then already had a depth of 2,400 feet, measured from the brow of El Capitan. It was, however, a much narrower and less impressive chasm than the Yosemite of to-day; it was a "three-story canyon" no wider at bottom than the channel of the river itself and winding sharply among craggy spurs that projected alternately from either side. But it was adorned by cascades of remarkable height: Illilouette Creek cascaded down 600 feet; Indian Creek 1,500 feet; Yosemite Creek 1,900 feet; Meadow Brook 2,300 feet; Sentinel Creek and Ribbon Creek each 2,400 feet.

And now came that epoch of cold climate which brought on the great Ice Age. Snow gathered to depths of hundreds and finally thousands of feet in the upper valleys of the range and, becoming compacted to granular ice, formed glaciers that slowly crept down the canyons, moving a few inches to a few feet each day. Small remnants of these ice streams remain to-day on the shaded sides of the highest Sierra peaks, notably on Mount Lyell and its neighbors. Two great glaciers advanced, each more than 2,000 feet thick, one through the Little Yosemite, the other through Tenaya Canyon, and, joining at the head of the Yosemite, formed a mighty trunk glacier that filled the chasm to the brim and extended ten miles down the Merced Canyon.

For hundreds of centuries this glacier held sway, quarrying and scouring the rocky sides and floor of the chasm with tremendous force, due to its weight and its

irresistible forward movement. It excavated the chasm 600 feet more at the lower end and 1,200 feet more at the upper end. It cut off the projecting spurs and wiped the inner gorge out of existence. Then the climate grew milder, the glacier by degrees melted back to its sources on the crest of the range, and for an interval that doubtless also lasted hundreds of centuries the river resumed its work. At the end of this interval the glacial climate returned and the Yosemite again fell under the dominion of the ice. But this time the glacier was much shorter and thinner; it reached no farther than the Bridal Veil Meadow and filled the valley only one-third of its depth. Moreover, the glacier was relatively short lived, and it therefore accomplished much less excavating than its mighty predecessor, whose work, however, it accentuated.

And so, when at length the Ice Age came to a close the narrow three-story canyon had been transformed into a broad U-shaped trough; the craggy slopes had been quarried back to vertical cliffs, and the broken cascades replaced by leaping falls. (See Fig. 4.) Moreover, three new falls of this kind had been created, for in deepening the chasm the glacier had left the gulch of Bridal Veil Creek hanging, thereby causing that stream to leap over a vertical precipice 620 feet high; and in its descent from the Little Yosemite the glacier had hewn a giant stairway down whose steps the Merced now makes two successive leaps, in Nevada and Vernal falls. Finally, a basin had been scooped out in the rock floor of the valley, and in this basin was formed a lake five and a half miles long—ancient Lake Yosemite. Similar but smaller and shallower lake basins were scooped out in the Little Yosemite and in Tenaya Canyon.

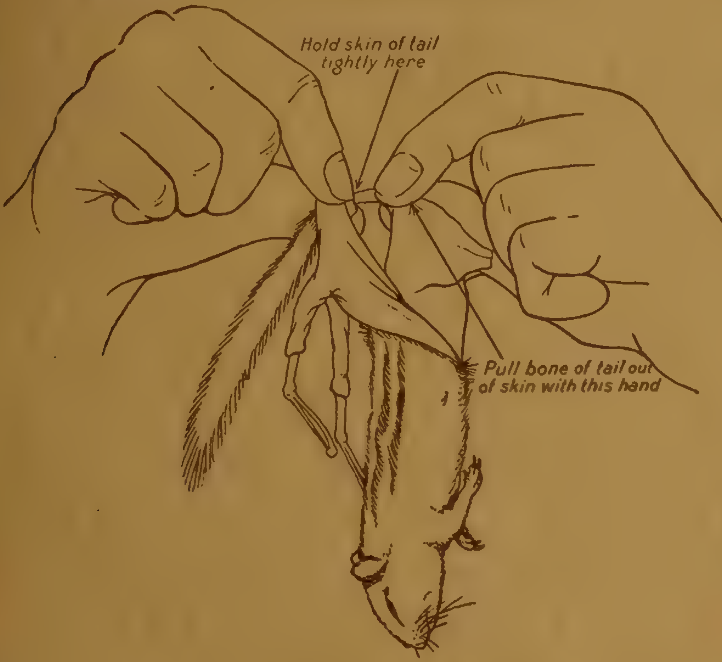
The ice was greatly aided in making these prodigious changes in the configuration of the Yosemite Valley by

F. E. Matthes, Photo

THE HALF DOME
From the trail beneath Glacier Point

THE AMERICAN MUSEUM OF NATURAL HISTORY

The Capture and Preservation of Small Mammals for Study



By H. E. ANTHONY

GUIDE LEAFLET No. 61

NOTE

This leaflet is one of a series intended to furnish accurate information in regard to the preparation of specimens of various kinds for Museum purposes.

The following have been issued and may be purchased at the sales booth or from the Librarian; others are in the course of preparation;

The Capture and Preservation of Small Mammals for Study
By H. E. Anthony. Price 15 cents

The Preparation of Birds for Study
By James P. Chapin. Price 15 cents

How to Collect and Preserve Insects
By Frank E. Lutz. Price 10 cents

The Preparation of Rough Skeletons
By Frederic A. Lucas. Price 10 cents

Suggestions to Collectors of Reptiles and Amphibians
May be had on application to the Curator, Department of Herpetology

Brief Directions for Preparating Skins of Large Mammals
May be had on application to the Curator, of Mammals

THE CAPTURE AND PRESERVATION OF SMALL MAMMALS FOR STUDY

By H. E. ANTHONY
Associate Curator of Mammals of the Western Hemisphere

The American Museum of Natural History
Guide Leaflet No. 61
New York, November, 1925

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CONTENTS

THE CAPTURE AND PRESERVATION OF SMALL MAMMALS FOR STUDY

By H. E. Anthony

The small mammals of any region are apt, with certain exceptions, to be less known than the large mammals. Small species which are active in the daytime, such as squirrels, are quickly noted and become familiar, but by far the greater number of small mammals are nocturnal in habit and hence escape observation unless special methods are adopted for their capture. The sportsman and large-game hunter acquaints himself in a short time with the appearance and habits of the large mammals of a region. He may spend years in a place without knowing by sight more than ten per cent. of its smaller mammal fauna.

As a consequence of this ability of the small mammals to escape notice, there is far less known about them than about the large, more or less spectacular mammals which the sportsman hunts for the pure love of the chase. Many of these game mammals range over extensive territory without becoming differentiated in any way or at the most differing only as subspecies. There is very little chance today for a large-game hunter to shoot a species new to science. On the other hand, there are very excellent opportunities for him to collect small mammals which have never before been taken, if only he will divert some of his attention to the mammals which he has been in the habit of considering beneath his notice. The shooting of a bear or lion is an achievement attained by thousands and often only a question of a moderate expense of time and money. These creatures were known to the ancients and the very nature of these animals demands that attention be paid them. There is no thrill of the chase, in the sense that one is risking his life, in the capture of some obscure, timid, and secretive small mammal, but if the species

is one that has never been known to Natural Science before, the discoverer should feel a satisfaction beyond that which attaches to ordinary trophies. It is distinctly worth while for the sportsman to spend some of his time and efforts upon the smaller mammals of the region he visits; especially is this true if he is hunting in some out-of-the-way corner of the globe, for the study skins he may bring back might be of far more value to Natural Science than the large animals which have always been filling the eyes of the sportsmen.

This is not intended as a dissertation against the scientific value of the large mammals,—far from it. Many of the large species are rapidly becoming extinct and if life-histories and intimate knowledge of these last survivors are to be obtained, surely no time must be lost. It is true, however, that a strong plea for the collecting of study skins exists, and men who go to great expense to reach new hunting fields could do a great service to museums, and to the knowledge of Natural Science, if they brought back with them as many of the small mammals as they could conveniently secure without interference with their plans for large game. Natives are often able to attend to the routine preparation of the material, or can be taught to do so, and the operation of a trap-line will not disturb the large mammals in any way.

This handbook has been written in response to a definite demand coming from two separate sources. Many of the sportsmen who plan trips to remote regions have made inquiry at this Museum as to what they might collect which would be of value for museum purposes. Their willingness to assist the aims of the Museum extends not only to the securing of the larger species for the exhibition halls, but also to a desire to be on the lookout for any mammals which have an especial interest or some particular bearing on any problem before the Museum. It may happen that the region under contemplation is the home of some much-desired small mammal and the offer of coöperation is decidedly welcome.

It is necessary then to instruct the sportsman in the methods of capture and preparation of small mammals.

The other class of naturalists for whom these pages are written is the man or boy who feels a definite calling to take up the study of wild life and who wants to know how to go about it. He may know something about removing the skin of a small mammal but he knows nothing about what constitutes museum methods and practice.

What is a Study Skin?

A well-equipped museum has, in addition to the mounted specimens of mammals on public exhibition, large series of specimens made up into what are called study skins. These series are necessary in order that the species may be studied to best advantage; that we may know whether the color of the animal varies with season, sex, or age, whether two mammals of similar external appearance really are the same in internal structure, etc., etc. It would be out of the question to attempt to care for the large collections brought together for this purpose by mounting them and placing the animals in the glass cases of the public halls. Study skins must be kept in storage cases that are light-tight, to prevent fading of color, and insect-proof; and the skins must be so prepared that many can be placed in one storage case. The method of making study skins strives to accomplish these two ends,—the preservation of all of the characters possessed by the animal when alive, and the production of a specimen which will be easy to store, protect and study. There is nothing in the preparation of a study skin which prevents the later mounting of the specimen for exhibition.

Tools Needed

Study skins of small mammals may be prepared with a small pocket-knife as the only tool, but skins may be made better and with less time if a few simple tools are secured.

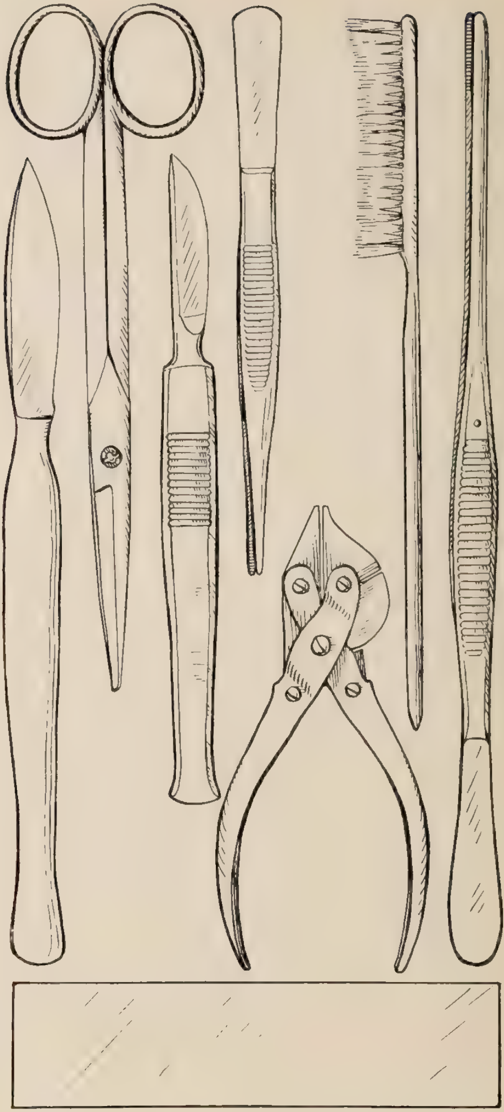


Fig. 1. Most important tools for making skins of small mammals.

The following will answer practically every purpose, but collectors develop individual methods and in time one might add several implements to this list.

1 steel tape, one or two meters long, marked in millimeters
1 steel ruler, about a foot long, marked in millimeters
1 small scalpel
1 large scalpel
1 pair of small, straight scissors
1 small pair of forceps or tweezers
1 large pair of forceps
1 tooth-brush
1 pair of pliers, with wire cutter
1 small carborundum oil stone

Additional tools that will probably be useful include extra scalpels, a larger skinning knife, a flat file, a steel comb, a larger pair of scissors, etc.

SUPPLIES NEEDED

Preservative

The skins of small mammals are best preserved by a mixture of arsenic and powdered alum (ammonium), the proportion about half and half by volume or by weight. Arsenic may be used without the alum but in a warm climate it is safer to employ alum to set the hair while the skin is drying. Do not use salt on a skin that is to be closed up, such as a chipmunk that is sewed up as a study skin. Sometimes when a collector runs out of arsenic he may make up his specimens without any preservative, and the skins will dry satisfactorily. They must be poisoned with the arsenic at the first opportunity, however, lest they be attacked by beetles (*Dermestes*) or moths, which may eat off all the hair.

A pound of arsenic mixed with a pound of alum will poison and preserve a great many small mammal skins, and five pounds of each powder will serve for quite an extensive expedition and for hundreds of small specimens.

The arsenic-alum mixture can be kept either in a flat, wide-mouthed tin (friction-top) or in a paraffin bag, made double by putting one bag into another.

Cotton and Tow

Cotton is employed as filling for small skins and may be secured in several grades. Tow, however, is the principal substance used for stuffing study skins, and if a fine, soft grade of tow can be purchased, the collector will seldom use his cotton. The tow should have long, soft fibers, and be free from lumps and dirt.

The very smallest skins need cotton, shrews, for example, being rather too tiny to fill with tow. For this purpose a fine grade of cotton, Dennison's best cotton, or jeweller's cotton, should be selected. One half-pound roll of this will last a long time for the average collecting.

The cheaper cotton is useful to pack around dried skins, since it comes in a rolled-up sheet that may be opened out to lie smooth and flat.

Five pounds of the ordinary cotton and five or ten pounds of tow will be all that is needed for several hundred small skins.

Absorbent

The best absorbent to use in skinning and cleaning skins is fine, dry cornmeal or fine sawdust. Used freely, cornmeal is such an aid to skinning that plenty of it should be kept on hand. It can be used over and over again, simply throwing away each time only the bloody portions, and is best kept in a waterproof bag, the mouth of which can be rolled down and kept open when in use.

Three to five pounds of cornmeal will last as long as the cotton and tow listed above.

Needles and Thread

A paper of assorted needles to take No. 25 and No. 50 or 60 linen thread will be needed.

A spool of each of the sizes of thread listed, preferably white, will be ample for sewing up the skins of several hundred mammals, but if thread is used for other purposes, such as on labels or wrapping up skeletons, more spools of the coarser size will be needed.

Pins

Ordinary white pins may be used for pinning out skins to dry, but experience will soon demonstrate that the black steel pins with the round glass heads are very much more satisfactory. The larger heads of the steel pins save the skin of the fingers and the hard points stick into the drying board better. At least five hundred steel pins will be needed for active collecting and a paper of the white pins will be useful for pinning paper about the dried specimens.

Labels

The American Museum of Natural History furnishes labels of standard pattern to its collectors. Such a label is shown in Figure 17. Lacking such a label, ordinary stringed tags such as Dennison makes may be used. Labels should be tied on firmly and a makeshift label that may be lost should not be used.

Wire

Wire in various sizes is needed for the tails of small mammals. A non-corrodible wire is much to be preferred and the American Museum has been using monel-metal wire with good success. The sizes needed are Nos. 16, 18, 20, 22, 24 and 26. Mammals needing wire heavier than No. 16 are seldom made up in the field. Only the smallest of mammals require a wire as small as No. 26. By far the greatest number of skins will be prepared with Nos. 18, 20 and 22.

The weights of wire needed will vary with the region where collecting is done. If many large squirrels, rabbits, etc., are wired, the larger sizes will be required and five pounds of wire will not last long. On the other hand, a pound of No. 22 wire will serve for a hundred or more of small mammals.

Insecticide

In addition to the use of arsenic on the flesh side of skins as a deterrant for insects, it may be necessary to put some insecticide in the box with the dried skins when they are shipped or to prevent ants from eating off the ears, toes and lips of skins that are drying. Various substances may be used for this purpose—Naphthalene being probably the best. California Insect Powder, Persian Insect Powder and Paradichlorbenzene (trade name, Paracide) may be used with success. The Paradichlorbenzene is especially effective but slowly evaporates if left out in the open; it is non-inflammable and non-explosive.

Alcohol and Formaldehyde

Alcohol is very useful for preserving specimens entire or for such soft parts of the anatomy as may be desired. The alcohol should be at least 85%. Avoid hardening the specimens by using the alcohol too strong, but beware of a weak solution in a hot climate.

Formaldehyde as obtained in a commercial solution generally runs about 40%. This solution may be diluted considerably. Take one part of formaldehyde by volume to from 10 to 15 parts of water, depending on the nature of the specimen, the climate, etc. Since formaldehyde hardens and contracts tissue, it is advisable to use it in a solution as dilute as will preserve from decomposition, and this may be as weak as a one to twenty solution under favorable circumstances.

Make certain that specimens are thoroughly immersed when placed in liquid; especially make sure that the fur is wet through.

Ink

India ink or water-proof carbon ink (Higgins' is an excellent brand) should be used for entering data on labels and in catalogues. Since the labels are comparatively small in size for the data that sometimes must be written on them, it will be found that a fine steel pen is best, because with it the letters may be kept small and entries legible. If the collector can print his data rather than write it, the label will be neater, but this, of course, is a refinement which adds nothing to the characters of the specimen itself.

The data on skull labels may be written in with pencil if a paper or card label is used. The writing must be heavy enough to insure its permanence.

GENERAL INSTRUCTIONS FOR THE CAPTURE OF SMALL MAMMALS

Most small mammals will be secured by trapping: a comparatively few will be shot.

Squirrels and rabbits will more often be shot than trapped. For shooting small mammals a double-barrelled shot-gun is best and a 16-gauge gun will answer all but the most unusual requirements. The right hand barrel should have a modified choke, the left should be full-choked. Auxiliary barrels, to be fitted inside of the 16-gauge bore, are very useful devices and do not add greatly to one's equipment. The auxiliary barrels now used by the American Museum are .32 caliber, using the old .32 extra long center-fire shell (to be obtained only on special order from the factory) and .410 caliber, using a paper shell which can be obtained without difficulty ready loaded. The length of the auxiliary barrels is about five to eight inches and the barrels may be carried in the pocket when not used in the gun.

For the 16-gauge shells, No. 6 shot is the best all-around size, but there will be use for No. 8 and No. 10 shot, as well as for No. 12—if bats are to be collected. Larger sizes of shot up to BB and buckshot will be required, of course, for general collecting. The small shells for the auxiliary barrels are most often loaded with No. 12 shot.

It would be impossible to give, in this handbook, complete instructions for the successful hunting of small mammals in each part of the country. Local conditions require special methods and it is presumed that any one who is seriously using this manual has probably already had at least the average hunter's experience and will know how to hunt for squirrels, rabbits and such small game. Space may be taken for a few hints, however.

The best time for hunting is early in the morning, just after sunrise, and late in the afternoon until it is too dark to

shoot. Look for the mammals where it is known that they feed. A tree of ripe fruit, a corn-field, a patch of clover, all offer a promise if visited at the right time. Some mammals may be called up by squeaking with the lips against the back of the fingers.

Often mammals may be shot by hunting with a light at night which could never be taken by ordinary methods of daylight hunting. Night hunting or "jacking," as it is sometimes called, is against the law in most of the states of the Union, but this practice may be followed in other regions where it is the most efficient method for large as well as small species.

The best light for the purpose is an electric flashlight, so constructed that the reflector with the bulb may be pinned to the hat in front and the batteries carried in the pocket. A five-cell dry battery gives a very strong light and will last for many hours of continuous use. Used for two or three hours a night, a set of batteries may last for several weeks. Carbide lights made especially for jacking are on the market but are so cumbersome and inefficient as compared to an electric light that they should be used only as a last resort if the flashlight cannot be obtained.

The light is so fastened on the hat that when the gun is thrown up to the shoulder the beams of light follow the line of sight. Mammals are seen at night by the reflection from their eyes and it is seldom that the hunter sees more of the game than the two glowing spots. The color of these spots varies with the species of mammal and may be bluish for deer, reddish for cats, etc. The color of the eyes and the distance between them serve as identifying characters. Care must be taken to avoid accidents. The eyes of cattle, horses, and other domestic stock shine beautifully under the light and it is much better to be cautious at first than sorry afterward. Night hunting will never make the collector popular with the natives if he shoots first and learns afterward. The eyes of man do not reflect light, at least under normal circumstances.

It is not unusual for a hunter to fire at a star when shooting at night. The wind moves the leaves of a branch aside and the star seems to move as would the eye of an animal. A good test under such circumstances is to watch the supposed eye when the light is on it and after the light has been turned to one side. If the "eye" remains visible when the light is removed it is a "star" but if the "star" shines only when the light is on the spot it is an "eye." The eyes of many creatures shine at night and it will require some experience before the hunter is able to identify what he sees. The eyes of spiders, moths, and insects often shine and sparkle amazingly; owls and night-birds, such as the goatsuckers, have luminous eyes that are very misleading; lizards may reflect light from the eye, and alligators and crocodiles send back the rays of light.

It is advisable when hunting at night, especially when in an unknown region, to reconnoiter first by daylight and learn the terrain and the features of the topography. This not only helps to bring the hunter back to camp the same night, but serves to prevent shooting-up a native's barnyard, and locates fruit trees where mammals are feeding, streams they may visit, etc.

Care of Mammals after Shooting

When a mammal is shot the specimen should be so cared for that no unnecessary bleeding takes place. A hunting coat with large pockets is suitable for specimens the size of a squirrel. Smaller mammals should be carried to camp and skinned there. Larger specimens, the transportation of which is troublesome, may be measured and skinned out roughly where they are shot. Details of the skinning which require time, such as skinning out the hands and feet, may be left until later. Wounds may be plugged with cotton and the bleeding checked. If the temperature is high and the specimen may spoil before it can be given the time to skin it out, the removal of the viscera is advisable. In some cases it may

be advisable to wash the body cavity with a weak solution of formaldehyde, or even to inject a specimen with this solution.

Trapping Small Mammals

Trapping of small mammals is not difficult in most temperate regions, but in some places, notably in tropical America, it is an art not easily acquired. A trap-line should contain as many traps as the collector can give his attention to, after the various duties of a day are taken into consideration. In the tropics, where traps must be visited soon after sunrise and specimens must be skinned out the same day they are caught, the trap-line should be neither too long nor too far removed from camp. Where high temperatures do not exist much greater latitude may be taken.

To get a complete representation of the small mammals of a region, a collector should run a line of traps in every definite life-association area. That is to say, traps should be set along streams and ponds for the aquatic species, at the foot of trees, on logs or on boughs for the arboreal mammals, in high grass and bushes for the meadow-loving forms, and in burrows and holes for the digging or subterranean creatures. A good plan to follow is to set out traps so that by following an arc of a circle the collector will place some of his traps in each one of the special situations the region affords. A trap-line that leads directly away in a straight line may capture just as much as one that curves back again toward camp, but the time element is more in favor of a line that can be inspected both on the way out and back into camp.

It is no easy task to set out a large number of traps and then locate them the next morning without loss of time. By following prominent features of the topography this task is simplified. Traps can be set along a trail or a stream in likely places, or along the crest of a ridge. It is a help to place small markers on the twigs or vegetation near the trap and to adopt a system which tells something of the position of the traps.

A tuft of cotton twisted about a twig or blade of grass will catch the eye and call attention to the trap. If nesting birds remove the cotton, short lengths of white string may be used. Single markers may be used on each trap except for the third, when two markers are set out. A bit of colored calico could be used on the fifth trap. When running the line, therefore, the collector knows he must find three traps for

Fig. 2. Showing trap set close to log.

each double marker and five for each colored one. This often saves time and avoids running the line back very far to find the lost trap.

If natives are troublesome and steal traps too conspicuously marked, as they often do, another method must be employed. Twigs broken and hanging down, a blaze or knife-cut on a tree trunk, an overturned stone, and many other expedients will suggest themselves.

Quite often the most suitable places for traps are obvious to the collector. Under fallen logs, in holes under rocks or at the

bases of trees, in runways through the vegetation, or at any place where it is apparent that shelter or food exists, traps may be placed with confidence.

In some regions traps placed carelessly at random can not fail of a good catch; elsewhere, under conditions that appear much more favorable, a line of 100 carefully placed traps may yield only two or three mammals. When setting out traps it is advisable to place the trap so that animals may trip it in passing if they are not interested in sampling the bait. By taking advantage of natural lines of cover this can generally be done, and the figure on page 16 shows a trap placed against a log so that any rat or mouse running along in the shelter of the log must trip the treadle in passing.

When a runway is discovered the trap may be placed directly in it, preferably across the runway, because there is less chance of the mammal being thrown clear by the spring. It may be necessary to remove some of the floor of the runway in order to bring the trap flush with the surface. Burrowing mammals may be difficult to catch because they fill the trap with earth. Pocket-gophers and moles are especially troublesome in this respect, but the collector learns by the failures and evolves a technique to avoid this. Traps of special types are made for gophers and for moles and are more effective than steel traps.

Some aquatic mammals seldom run on the land and are not easily caught in the water. By searching for places where these mammals must take to land, at a waterfall for example, traps may be placed in the paths they must follow and specimens are secured. Under normal circumstances, mammals may be counted on to do the obvious thing, and this should be taken into consideration in the placing of traps. If a mammal standing on the ground is unable to reach a bait, it is quite apt to climb up on the nearest object which allows it to reach the morsel. If a low obstacle is in its path, it steps over it, and a trap may be set where the foot

comes down. The trappers of furs have many such methods, and while most small mammals apparently are not suspicious of traps, there are occasions when the resourcefulness of the collector is taxed.

The small traps for rats and mice should always be tied down to prevent a captured animal from dragging the trap away. Steel traps always have a chain fastened to them for this purpose but it will be necessary to put a cord or a small wire on the wooden traps. About two feet of strong, hard cord can be tied into the staple which holds down the trigger.

The bait for the small traps should either be sprinkled sparingly over the treadle and in front of the trap in the case of a loose bait, such as rolled oats, or else be placed directly in the bait hole in the treadle if the combination bait is used.

Small steel traps are often set, unbaited, in a runway or burrow. If a bait is employed it may be dropped here and there about the trap and then a few leaves scattered on top, or it may be suspended over the leaf-covered trap so that the animal steps into the trap while reaching for the bait.

Traps

The traps required for the capture of small mammals are of two main types. The traps for rats and mice may be of the common spring and board pattern, such as the Out-O-Sight; and the traps for the larger mammals are preferably a selection of different sizes of steel traps, the Newhouse and the so-called "jump" trap. These traps are standard and can be obtained almost anywhere.

The small traps on the market come in two sizes, a mouse size and a rat size. The American Museum has found it necessary to use a small trap intermediate in size between these, but such a trap must be made to order. Secure the best-made trap to be found; a cheap trap will warp and break after a hard rain. The Out-O-Sight trap has given the best satisfaction of any used by the American Museum. These

traps with wooden bases may be placed in hot paraffine for a minute or two and then placed in a warm spot to drain. This makes them water-proof and adds nothing that is distasteful to the animals which will visit them.

For active trapping at least 100 of the mouse traps would be carried and 50 of the rat size. Since traps occasionally break or are lost, a greater number will be needed for collect-

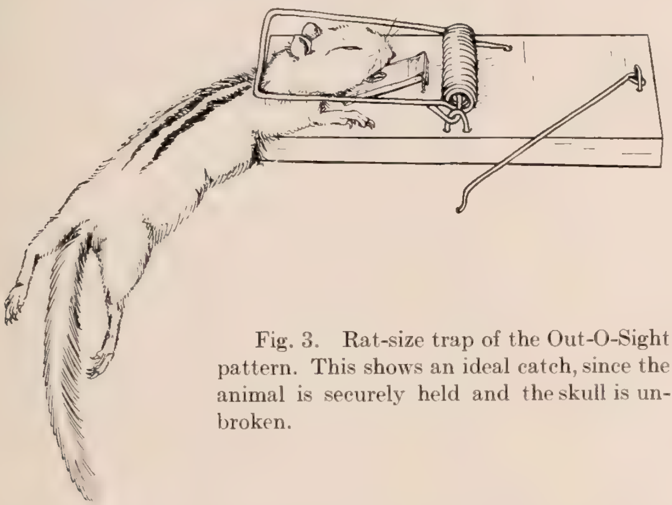


Fig. 3. Rat-size trap of the Out-O-Sight pattern. This shows an ideal catch, since the animal is securely held and the skull is unbroken.

ing extending over a long period. An average trap-line will mean about 100 traps out a night, more if mammals are difficult to secure, less if they are abundant. In some regions the proportion of rat to mouse size should be increased, or vice versa.

Baits

There are many baits which may be used successfully in trapping small mammals. Rolled oats is a standard bait for rodents. Bits of bacon, dried fruit, peanut-butter, cut-up vegetables or fresh fruit serve for rodents; and for the small

carnivores, scraps of fresh meat, bird bodies or carcasses from the skinning table may be attractive.

The most generally successful bait used by the American Museum collectors is a mixture or combination bait which I have worked out on the basis of field work in Ecuador. It is made as follows:

> One part of bacon, cut up into small pieces; one part of cluster raisins, also cut up small; two parts of oily peanut-butter; rolled oats sufficient to make the mixture of putty-like consistency.

The bacon and raisins may be run through a food chopper if much of the bait is to be prepared. All of the ingredients should be thoroughly mixed and the final product will keep for months or years if stored in a tight jar or tin.

This combination bait is attractive not only to rodents but to shrews, opossums, and other small mammals. Unless carried away by ants, the bait lasts for several nights and is unaffected by light rains because of its oily nature.

No very signal success has been obtained by the use of special scents, such as asafœtida, fish-oil, etc., in trapping for smaller mammals.

Poisons

The use of poisons is not generally recommended for taking small mammals. The circumstances seldom arise to justify the use of poison and because of the uncertainty of finding the mammal after it has left the bait, it is a wasteful process. On open, exposed areas, poison is sometimes the best means of securing foxes and small carnivores.

MEASURING AND LABELING OF SPECIMENS

Each specimen should have tied to it a label with the following data:

1. The number given to the specimen by the collector.
2. Locality or place of capture.
3. Date.
4. Sex.
5. Measurements.
6. Name of Collector.

1. A catalogue of the specimens collected should be kept from day to day and a number assigned to each animal as it is skinned. This number is written not only in the catalogue but on the label which is tied to the skin and on the label which is fastened to the skull.

2. The locality where a specimen has been taken may be shown in various ways. If the place is well known and to be found on the map, the designation may be by two or three words, as, for example, Hastings, New York. If, however, the locality is at a distance from any well-known spot on the map, a designation as above is hardly sufficient and an explanatory clause should be added, as, for example, Santa Rosa, Chillo Valley, east of Quito, Ecuador, altitude 8000 feet.

3. The date is best written out, May 7, 1925, not 5-7-1925, which might be construed either as the seventh day of the fifth month or the fifth day of the seventh month.

4. The sex is ordinarily determined by inspection of the external sex organs or genitalia and only rarely is it necessary to make an internal dissection to ascertain whether the specimen be male or female. The sex is best indicated on the label by sign, ♂ for male, ♀ for female.

4. The measurements are of considerable importance and should be taken in millimeters whenever possible. The measurements ordinarily taken are the total length, the

length of the tail vertebræ, and the length of the hind foot. European collectors and workers prefer to take the length of the head and body and the length of the tail, arriving at the total length, if they wish it later, by addition. The American method will give the length of head and body, if it is desired, by the process of subtraction.

The total length is the distance in a straight line from the tip of the nose to the tip of the tail, exclusive of the hair. The animal is straightened out so that there are no curves in

Fig. 4. Showing method of securing total length.

the vertebral column and, if *rigor mortis* has set in and the animal is stiff, the carcass must be stretched and manipulated to bring it into a natural position. Place the specimen on a board or table, as shown in the sketch, and set a pin at the tip of the nose and at the end of the last vertebra of the tail. It is possible to take the total length by holding a small mammal directly on a ruler, with the end of the ruler at the tip of the nose, and locating the tip of the vertebra with the thumb or fingernail, taking a reading from the ruler without recourse to pins. For one who is learning, the measurement will be more accurate if pins are used and the ruler applied to them.

The length of the tail vertebræ is taken as shown, from the base of the tail to the skin of the last vertebra. The tail is bent at right angles to the body to facilitate the taking of this measurement.

The length of the hind foot is taken from the heel to the end of the claw on the longest toe. The toes should be straightened out and the easiest way to keep the foot straight

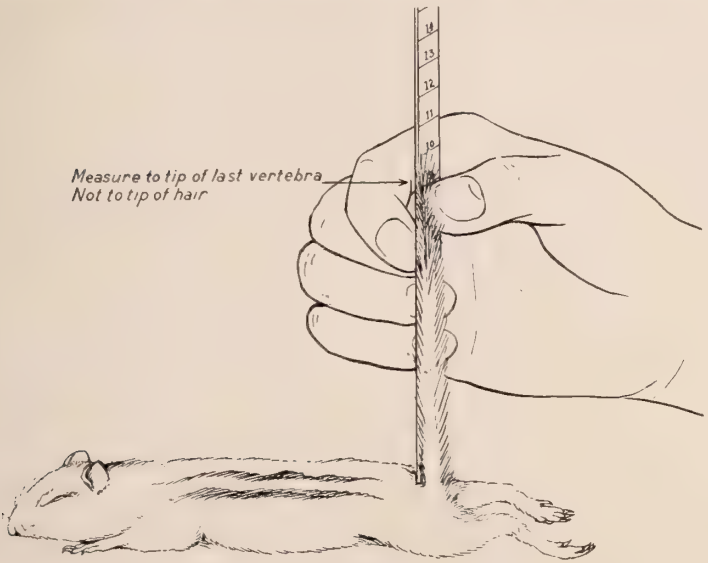


Fig. 5. Method of taking length of tail vertebrae.

is to press it against the flat side of the ruler, as in the figure. This way of taking the hind foot measurement to include the claw, often written as "length of hind foot, *cum unguis*," or simply "length of hind foot, c.u.," differs from the method employed by Europeans who measure only to the fleshy tip of the longest toe. This measurement without the claw is known as "length of hind foot, *sine unguis*," or "length of hind foot, s.u." Specimens collected for the American Mu-

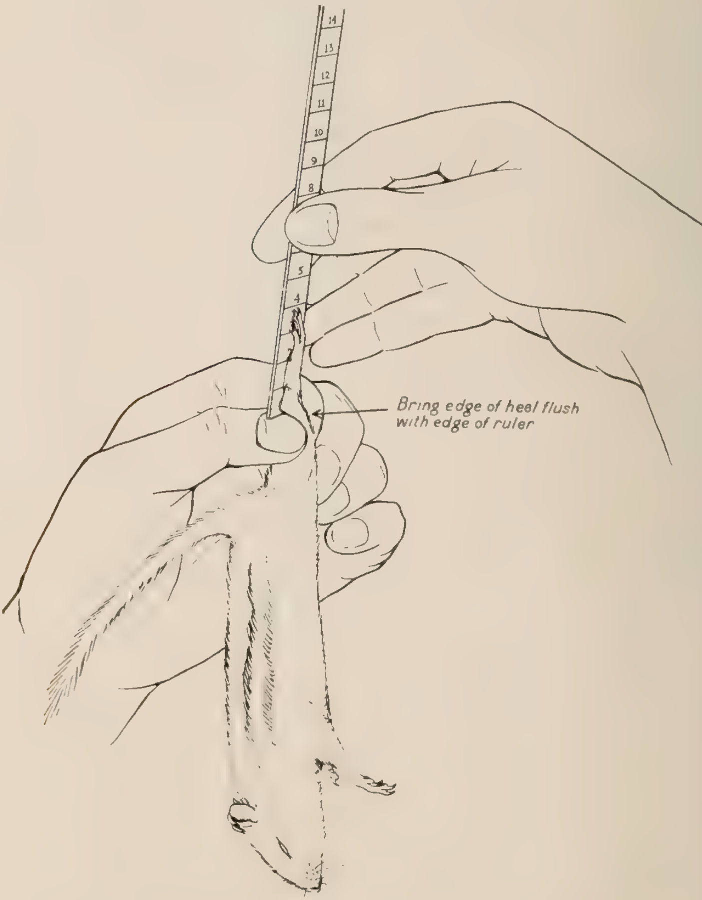


Fig. 6. Method of measuring the length of the hind foot.

seum of Natural History are always measured to include the claw in the length of the hind foot.

Sometimes the height of the ear above the crown of the head affords a valuable measurement. This is written on the label, "height of ear above crown," and may be taken by

placing the end of the ruler on the crown of the head at the base of the ear and then reading to the tip of the ear, exclusive of the hair.

Field Catalogue

It is important to keep a field catalogue of the mammals collected and to record in it all the data that is written on the label and such additional notes as seem worth while (see page 51). This catalogue may be any convenient size. The catalogues used by the American Museum give a line to a specimen, but the line runs across two pages and the data is entered in this order: collector's number, name of mammal (in the field this may be only "rat," "mouse," "squirrel," etc.), sex, locality, date, measurements, remarks. By writing remarks at the right-hand margin of the page there will be ample space, since extensive remarks will not be given for each specimen and if the part of a line regularly allotted to a particular specimen is not adequate, the note can be run over a line or two without crowding the page.

TO SKIN A SMALL MAMMAL

A chipmunk is selected as a typical small mammal, and mammals up to a raccoon in size are skinned in this fashion. The very first things to be done are the taking of measurements, the writing of the label, and the recording of data in the field catalogue.

With the chipmunk laid on its back, part the fur along the mid-line of the abdomen and make the opening cut from

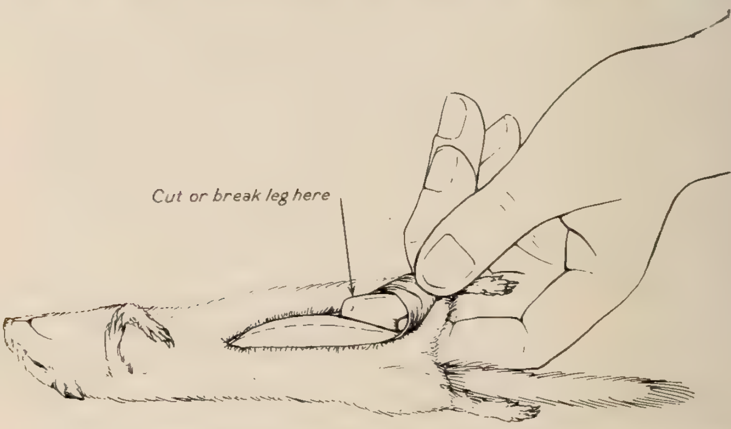


Fig. 7. Showing the opening cut and one leg freed from the skin at the knee

about the breast bone to the base of the tail. Figure 7 shows the extent of this cut, which should be through the skin only and not into the abdominal cavity.

Loosen the skin from the flesh along the sides of the cut, using the fingers or the flat end of the scalpel handle. A pinch of dry cornmeal dropped into the cut will be of considerable help in manipulating the skin.

Keep a container with cornmeal on the skinning table and do not be sparing in its use. Cornmeal not only absorbs the body juices, keeping the fur and skin clean, but the

Fig. 8. The leg has been unjointed at the knee and the flesh has been stript from the tibia.

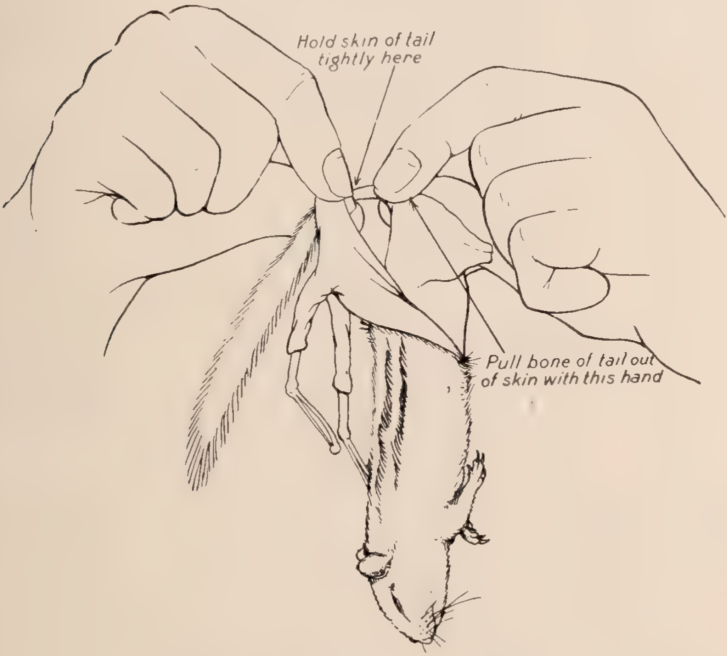


Fig. 9. Removing the tail vertebrae.

presence of the sharp grains on the fleshy side of the skin is a great aid in working and handling an otherwise slippery surface.

Work the skin loose from the knee and upper leg so that the knee-joint may be thrust upward, as in Figure 7, unjoint the leg at the knee and work the skin back as far as it will go. Clean the flesh from the lower part of the leg. See Figure 8.

Skin out the other leg in the same manner.

Cut away with the knife or scissors any tissue at the base of the tail and work the skin of the tail loose until it may be grasped as in Figure 9. The skin may be grasped between thumb and forefinger with the fingernails serving to strip the skin from the bone. Forceps may also be used to do this stripping. A steady pull on the base of the tail should bring the vertebræ out entire. Occasionally a mammal is found, the tail of which must receive special treatment, or a shot may have cut a vertebra. In that event the skin of the tail may be split for a short distance along the under side and sewed up afterward.

With both legs and the tail free, the skin is rolled back until the forelegs are reached. This parting of the skin from the body may be accomplished partly by manipulation with cornmeal and the blunt handle of the scalpel, partly by cutting strands of tissue here and there.

The skin should never be pulled until it stretches, at any stage of the skinning.

The forelegs are worked free of the skin, unjointed at the elbow, and cleaned in much the same manner employed for the hind legs. See Figure 11.

The skin is then rolled back until the bases of the ears are reached. Cut these with the scalpel as close as possible to the skull. Do not cut the bone of the skull, however. See Figure 10.

As the skin is worked over the head, the eyes will be exposed. Cut the eyelids free with the point of the scalpel,

working carefully to avoid cutting the lid. This means that the point of the knife must work deep. Probably the novice will learn just how deep only by passing through the experi-

Fig. 10. Skinning about the ears.

ence of cutting off a few eyelids. The skin is cut free at the nose by slicing through the cartilage; take care not to cut the delicate bones of the nose.

The skin finally parts from the body at the lips and is now turned inside out, as shown in Figure 11. Clean off any bits of fat or meat on the skin. It is especially important that

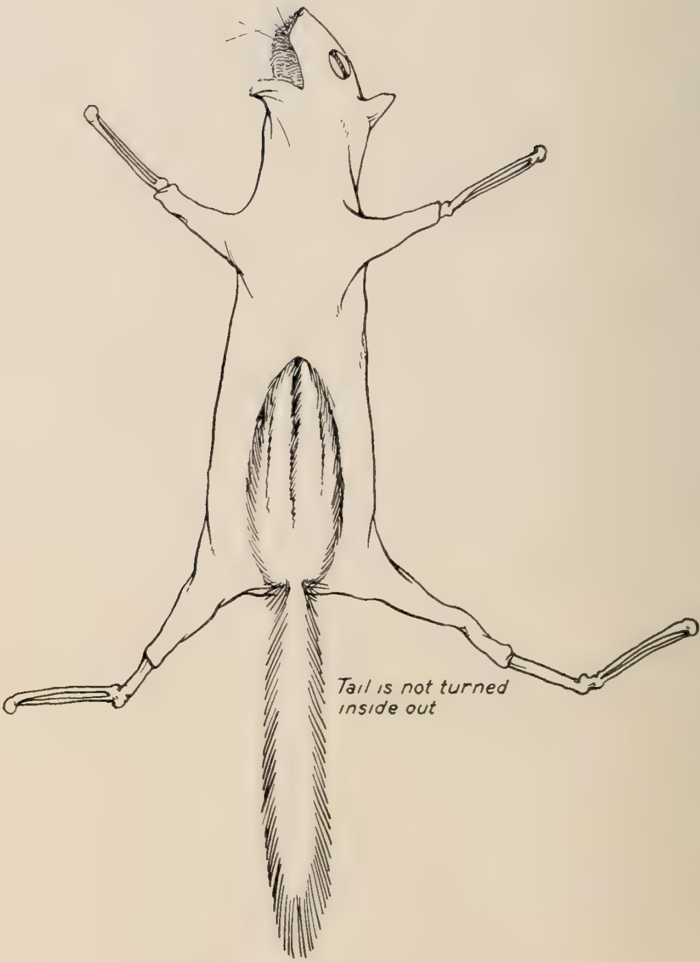


Fig. 11. The skin removed from the body.

all fat be removed from the skin. Take three stitches to close the lips. See Figure 12. Do not take these stitches too deep into the lips.

If the skin is especially greasy or bloody it may now be washed thoroughly inside and out with soap and water or in benzine. Avoid stretching the skin while it is thus wet and lax but otherwise it may be handled like a piece of cloth. Squeeze out the surplus moisture; do not wring out the skin lest it stretch; and dry the fur by a liberal use of dry corn meal or sawdust. As fast as the cornmeal absorbs moisture and becomes damp, replace by fresh, dry cornmeal and very shortly the fur will be dry and fluffy. The skin may then be turned inside out again to be poisoned.

Fig. 12. Stitching the lips.

Now dust over the skin thoroughly with the arsenic and alum mixture, using a small brush, a rabbit's foot, or a tuft of cotton on a stick. See that the powder comes in contact with every part of the flesh surface. Work some of it into the tail, using a wire to dust it down past the base of the tail.

It should be needless to caution the worker that the arsenic mixture is poisonous if taken into the stomach. It is also a powerful irritant if it gets under the fingernails. The use of cornmeal in skinning generally protects the fingers, because the cornmeal gets under the nails first and prevents the accumulation of arsenic there. Do not dip the fingers into the arsenic if it can be avoided.

Shake off any surface arsenic and alum; turn the skin right side out.

If the mammal is of fairly good size, and the climate is

such that skins do not dry quickly, it will be advisable to slit the soles of the feet in order to get arsenic in at the base of the toes and about the phalanges. Perhaps it will be possible to remove some of the fleshy tissue from the soles of the feet through this opening, which can be made either at the extreme edge of the palm or sole, or down its median line. The opening may be closed by a stitch or two after the preservative has been sifted in.

TO FILL OUT THE SKIN OF A SMALL MAMMAL

Prepare a body of tow for the chipmunk, pulling out the fibers until all point the long way of the body. Do not make the body too large: judge the size somewhat by the size of the carcass you have just removed but remember that the tow will compress.

Bend over the tow at the extreme end of the body so that the short ends of the long fibers are directed back along the body and the head end of the tow form is bluntly rounded. Grasp this end with the forceps and insert the tow into the skin, working it into the head and nose, as shown in Figure 13. Fill out the nose and shape the head, drawing the skin of neck and body smoothly over the form. Cut off the tow so that the new body just fits at the base of the tail.

Twist up a wisp of tow over the points of the forceps by twirling the forceps in the tow, slip the tow into the leg between the bone and the skin as far as it will go, grasp the point with the fingers of the free hand and the forceps may be withdrawn, leaving the tow in the leg. The leg should be drawn out straight as this is being done. See Figure 14. One wisp of tow is sufficient for the foreleg but two will make a better hind leg.

The next step is to wire the tail. Straighten out a piece of wire by pulling on it until it gives a trifle. Cut off a length equal to the length of the tail plus the length of the opening cut in the skin. The size of the wire should be such that it will go to the end of the tail and yet be stiff enough that it will not bend easily. In the case of species where the tail is long and tapers to a fine point, it may be necessary to dress down the terminal inch or two of wire with a file.

Twist a little cotton or tow tightly about the wire to fill out the tail. At first it may prove difficult to get a thin, even layer of cotton on the wire; the knack comes with practice and consists principally in adding the cotton, a thin wisp at a

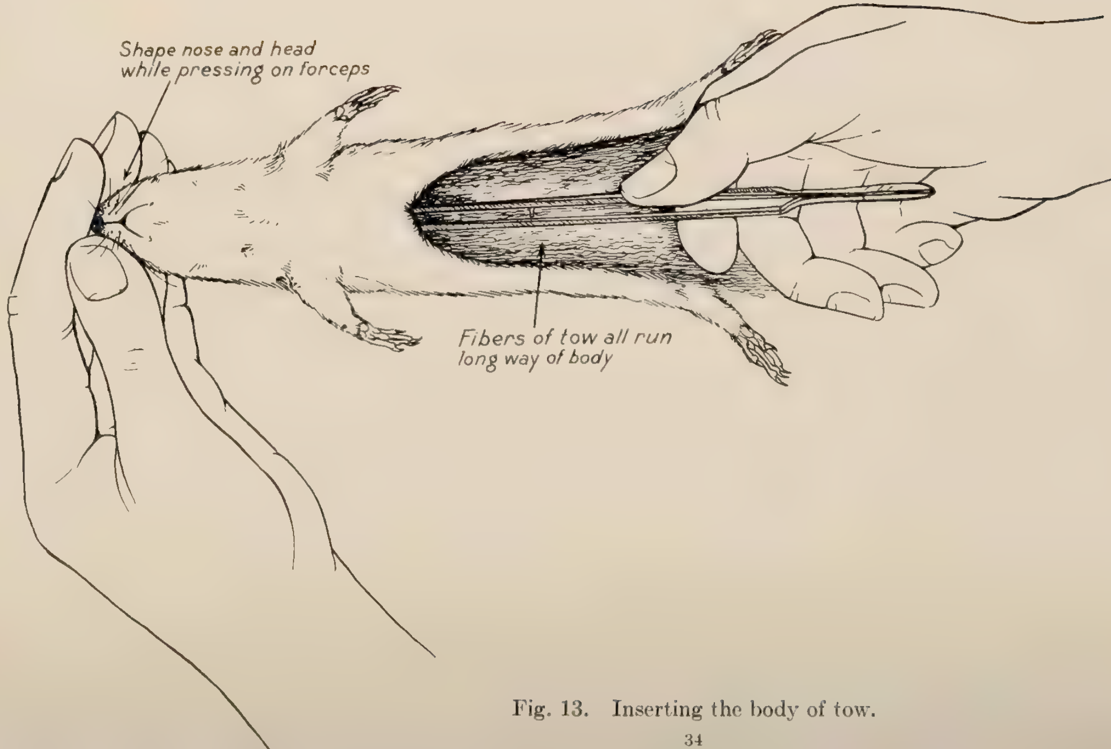


Fig. 13. Inserting the body of tow.

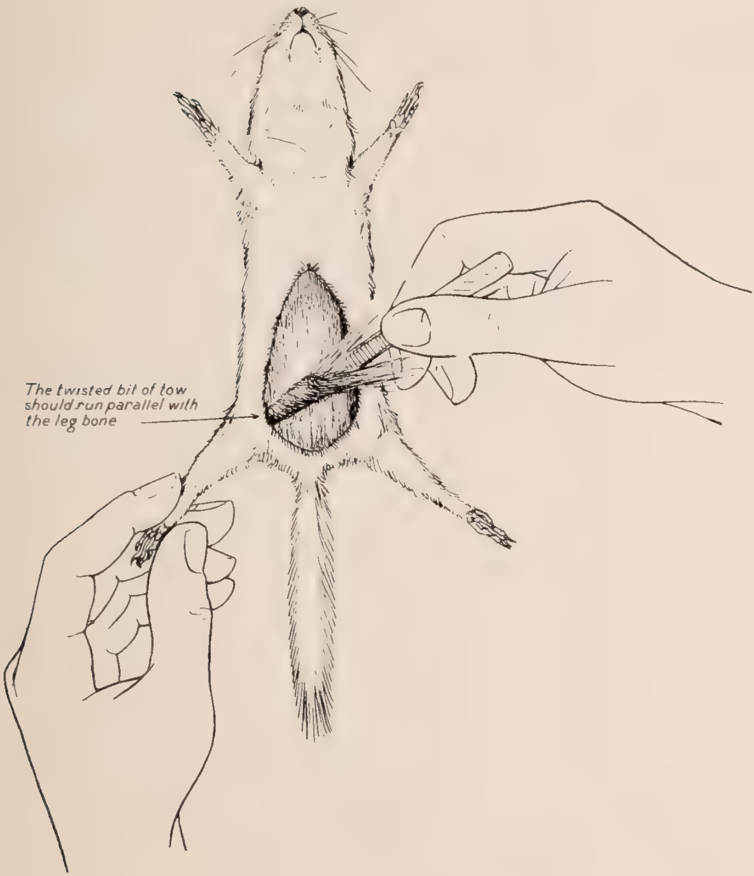


Fig. 14. Filling out the legs with tow.

time, and twirling the wire to make it lie flat. Be careful to not put on too much or you may push the tail off trying to get the wire in. By carefully working the wire down the tail it will go the full length and the part of the wire outside will slip into the cut along the abdomen. See Figure 15.

Lay the chipmunk on its belly and try a preliminary shap-

ing-up of the skin. See if it will look about as in Figure 17. It may be necessary to slip in a little more tow about the rump.

If the filling seems satisfactory the skin is then sewed up as in Figure 16. The thread will hold best if it is tied into

Fig. 15 Filling the tail with a covered wire

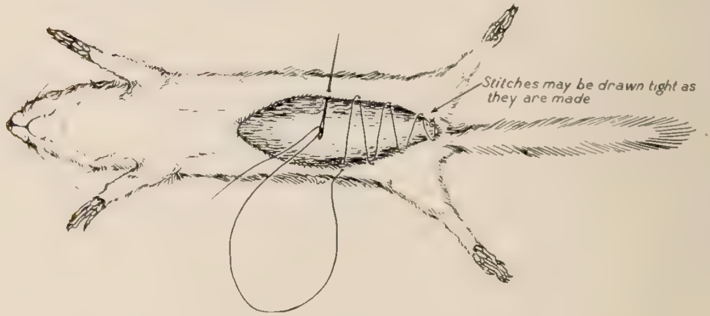


Fig. 16. Sewing up the skin.

the skin at the base of the tail. A knot at the end of the thread often pulls through. The thread should be caught with a single loop-knot where the sewing finishes off.

Take the tooth-brush and brush off any blood or dirt on the finished skin.

Fig. 17. The finished skin, pinned out.

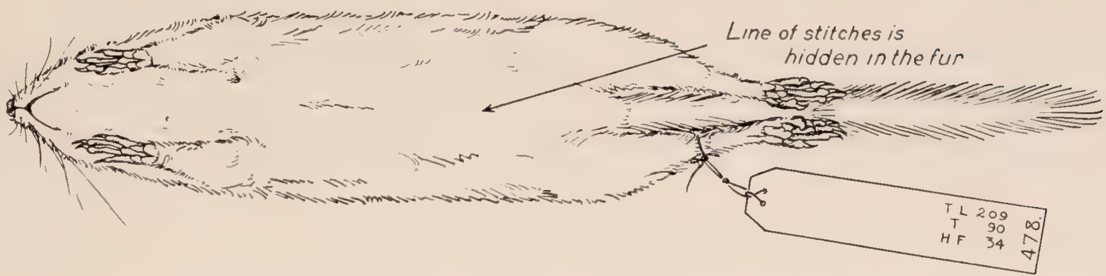


Fig. 18. The finished skin, from the underside.

Tie the label, with the complete data, on the right hind leg, making a secure knot just above the heel so that the thread can not slip off.

Pin out the skin on a board, running the legs close to and parallel with the body and arranged as shown in Figures 17 and 18. The position of the pins may be seen in the figures, one in each hand and foot, one at the side of each hind leg to keep the feet inclose, and two pins crossed over the tail.

Fig. 19. A skull properly labelled.

Remove the skull from the carcass by unjointing carefully at the neck. Cut off from the skull only the largest of the muscle masses in the case of medium-sized species but remove nothing from skulls of the small species. A certain amount of tissue dried onto the skull will protect it until it can be properly cleaned. Remove part of the brain with a wire, but it is not advisable to clean out delicate skulls too thoroughly in the field if they may be adequately dried. The thin vault of the cranium is very apt to be crushed unless special provision is made for its protection.

Remove the tongue and fasten on a skull label which has the same number on it as is on the skin. It is well for the collector to add his initials to the label also. If paper labels are used the number should be on each side of the label. No tragedy in a collector's experience is keener than the inability to match skulls with skins after they have been brought in from the field.

Do not allow skull labels to become stained with blood. Dip skulls into cornmeal; it hastens the drying and keeps the labels from adhering to the flesh. Do not dip the skulls into the arsenic-alum mixture. Do not allow blow-flies to have their own way with your skulls. The skulls may be kept on a wire and hung up out of the way of dogs or animals

to dry. Run the wire through the loop of wire or string on the label, not through any part of the skull. Skulls may also be dried out in a small box, one or more sides of which are screened. Above all, do not allow your skulls to get wet and remain wet; they macerate or decay when wet and the resultant discolored mass may be of little use to any one, if the decomposition goes so far that the jaws drop away from the skulls and the numbers cannot be associated with the skulls.

Very satisfactory skull labels may be made from strips of block tin or monel-metal; the number may be stamped on or scratched on with a sharp tool, and if the monel-metal wire is used to fasten the label to the skull, there is little chance for the label to become illegible or to drop off.

Small skins will require about a week or ten days to dry out under normal conditions. Keep them out of the direct sunshine, but where there is a good circulation of air. In the tropics it may be necessary to dry the skins by artificial heat. If this is done, keep the specimens as far from the fire as is possible and still dry them. Too much heat will hurt them and the smoke will stain them. When thoroughly dry they may be removed from the boards, wrapped in paper, and carefully packed in some suitable container.

Collecting Chest

Sketches are shown of the type of collecting chest which I have found most useful. A regulation army locker-trunk is the foundation. This trunk comes equipped with a tray (Figure 20) which lifts out and generally rests across two transverse cleats at the ends of the trunk.

Remove these transverse cleats and fit four upright cleats at the corners, as shown in Figure 21. These cleats should be high enough to support the large tray where it belongs, at the top of the trunk. The cleats should be about five-eighths or

Fig. 20. The tray which rests in the top of the collecting chest.

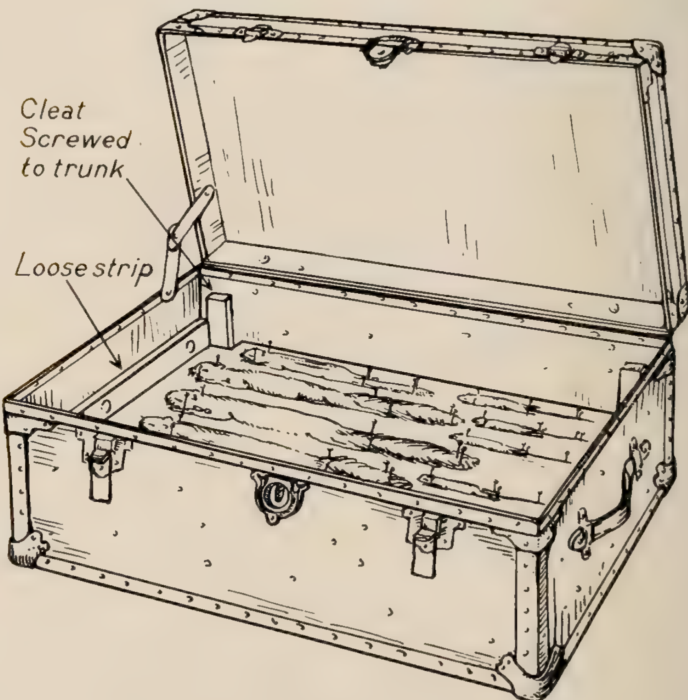


Fig. 21. A convenient collecting chest.

three-quarters of an inch in from the ends of the trunk to allow narrow strips to pass between them and the ends.

Five or six boards of thin material—I have found "compo-board" most satisfactory—are cut as shown in Figure 22 so that they will just drop easily to the bottom of the trunk. Two strips, the width of the board, are cut for each board but are not fastened to the board in any way. The width of these strips will govern the depth of the tray desired and should be

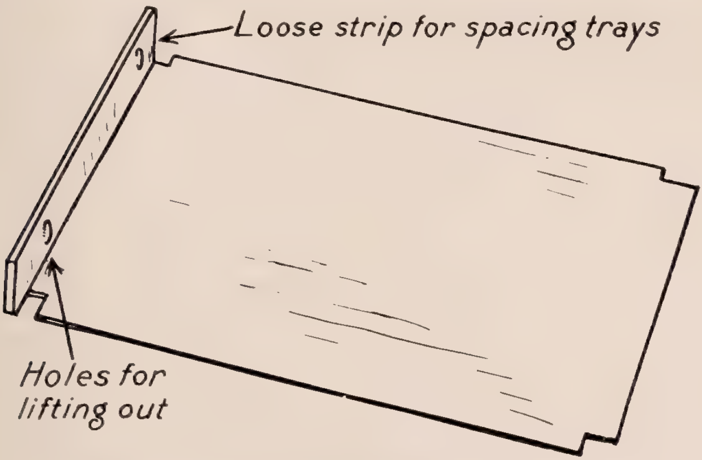


Fig. 22. A drying board with one of its two spacing cleats.

so figured that when the requisite number of boards and strips are assembled, as shown by Figure 21, the last board comes up to the level of the large tray. A useful width of strip will be one and a half inches for the average small mammal, but some may be only one inch and at least one pair will need to be three or three and a half inches wide.

The method of using these boards and strips should be obvious from the figures. The boards, when not in use, lie flat in the trunk and leave most of the trunk space available for packing. When skins are pinned out on the boards, the

boards are spaced one from another by dropping strips across the end. Holes at the ends of the strips allow the fingers to be inserted to lift the strips out.

If the skins are securely pinned into the soft wood, they will not shift during transportation. Skins should be pinned rather closer to one another than is shown in Figure 21. In placing mammals, allow for the space taken up at the end by the strip which will be inserted later. A thin layer of cotton laid upon the skins will make them still more secure when pressed down by the board of the succeeding tray.

Handy containers for dried skins are made by cardboard suit boxes. These are obtainable in flat, unassembled shape, and fit into the bottom of a locker trunk after they have been bent over at the side or end. This bending is along a line later used for the assembled box, so that no harm is done. The suit boxes filled with dry skins are later packed in whatever containers are available for shipment, and, because they may be securely packed as units, the skins come through in better shape than if they were packed directly into the large container.

When dried skins are permanently packed up they should be laid out flat and close to one another, so they can not shift about. Each skin should be wrapped carefully in a piece of paper before it is finally packed. It is advisable to separate each layer of skins by a thin sheet of cotton and to fill in any cavities with wads of cotton or tow. If the layers are very uneven, a sheet of cardboard might be employed to even up the pressure on the skins. Scatter naphthalene flakes in among the skins as they are packed.

Do not pack skulls with the skins if it is reasonably possible to avoid it. Insect life that has been feeding on the skulls may attack the skins. If skulls must be packed with skins, kill any insect life in the skulls by dipping them in a solution of arsenic and water, in weak alcohol, or even in weak formaldehyde. A short immersion kills all insects and does

not injure the skulls. Needless to say the skulls are thoroughly dried again before packing.

THE PRESERVATION OF SMALL MAMMALS ENTIRE

It is often well worth while to save entire specimens of small mammals for future dissection and anatomical study at the museum.

For this purpose either alcohol or formaldehyde may be used. For strength of solution, see page 11.

The specimen is opened up along the belly, the cut penetrating into the abdominal cavity so the solution may reach the viscera. Take care that the knife does not cut any of the organs. For bats and other small mammals this cut is the only preparation required and they may be dropped into the jar or can of preservative solution. Labels with full data should be tied to each specimen, of course.

In the case of larger species, it may be necessary to inject some of the solution into the mammal because immersion alone will not be sufficient. A large, injecting, hypodermic needle must be carried for this purpose. When the animal is of such a size that the body fluids may so dilute the preserving solution that decomposition sets in, the weakened solution must be replaced by fresh liquid at the end of several days.

When many small specimens are placed in one container they should be wrapped individually in a little cheese-cloth or muslin; otherwise rubbing may take the hair off.

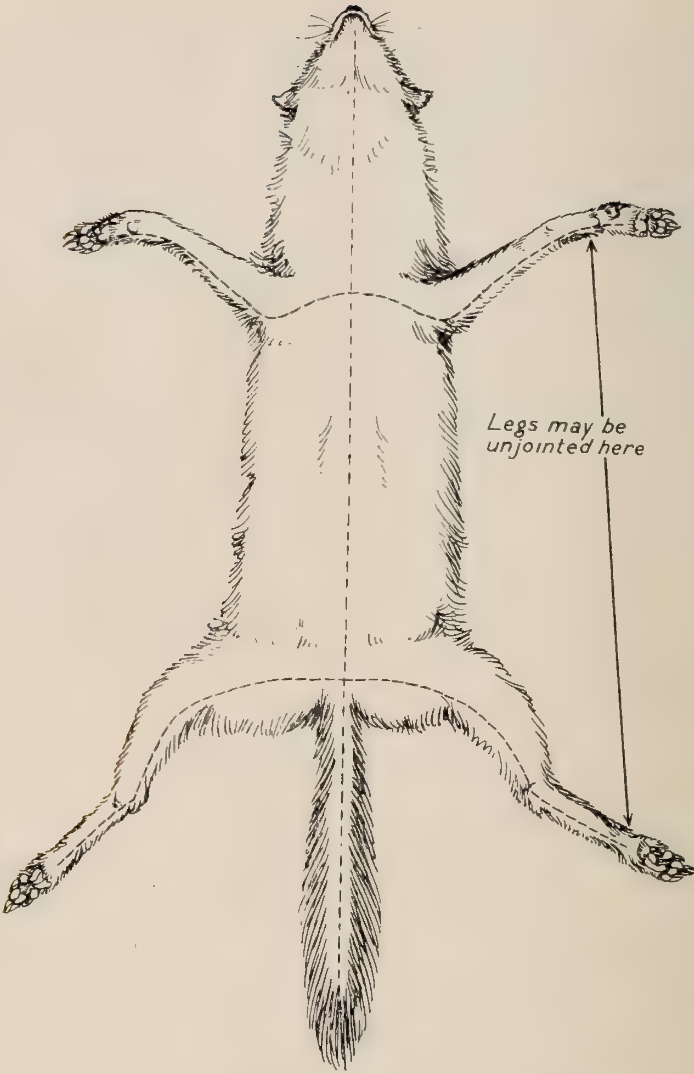


Fig. 23. Opening cuts for larger mammals.

TO SKIN A LARGE MAMMAL

If packing space is limited it may be advisable to fill out in the field nothing larger than a small squirrel. The skinning of these smaller mammals which are to be stuffed later is best done as described for the chipmunk.

Mammals larger than woodchuck, opossum or raccoon are seldom stuffed in the field. They are skinned in somewhat a different manner than that described for the chipmunk; the skin is poisoned and dried flat and is made up later at the museum.

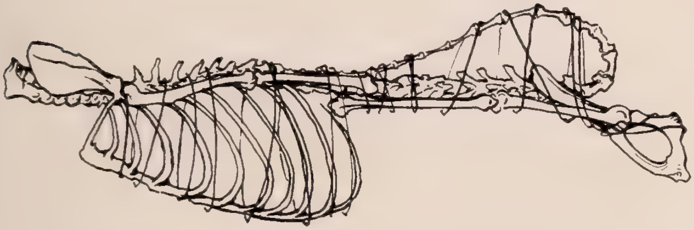


Fig. 24. Skeleton tied up for packing. This skeleton is rather better cleansed than will be necessary for the smaller mammals and a thin layer of flesh and muscles should be left to dry over the ribs and the processes of the vertebrae.

Measurements are taken as for the chipmunk. The opening cuts are shown in Figure 23. The skin is thoroughly poisoned and dried out over a cord or rope. Care should be taken that the skin does not wrinkle so that folds are closed off from the drying influence of the air. The dried skin is rolled up in a compact bundle.

Instructions for preparing the largest mammals, and the procedure to be followed in securing material to be mounted, are given in a separate publication.

Skeletons

The collecting of material for skeletons is also given in a separate publication by the American Museum of Natural History entitled, "The Preparation of Rough Skeletons," by Dr. Frederic A. Lucas. See Figure 24, showing a small skeleton prepared in the field.

In the case of very rare specimens it is often desirable to make as complete a skin as possible and to save as much of the skeleton as remains in the carcass. In this case the skin is taken off as usual, care is exercised to unjoint rather than break the limb bones, and the skeleton is prepared as described in the handbook just listed.

SAVING ODD MAMMAL SKULLS

In the majority of cases the skull is fully as valuable as the skin, and often constitutes the more valuable part of the specimen. For this reason the collector should save odd skulls without skins. For example, a specimen may be secured in such condition that the skin is valueless and the skeleton as a whole badly broken. The skull of such a specimen might show all of the essential characters of the species and be well worth saving. Odd skulls should have a record made in the field catalogue, and preferably on the skull label as well, that the specimen is "skull only." This saves trouble later on when one looks for a skin to match.

A valuable source of odd skulls is owl pellets. Many of the owls live largely on small mammals and, in the regurgitated pellets of these birds may be found skulls of practically all of the small mammal fauna of the region. From an inspection of these pellets, the collector can get a very good idea as to what he may trap for. The owl is a better collector than man can hope to be, and not a few species new to science have been based upon odd skulls obtained from owl pellets. Save all skulls found thus; they are valuable.

A good place to look for these pellets is near the entrance to caves, at the bottom of hollows in dead trees, or sometimes under limbs or cliffs where the owls have a habit of perching.

Collecting Bats

The collecting of bats presents problems quite different from those encountered in the pursuit of flightless mammals. Not only are bats difficult to secure, but they are also more troublesome for the novice to prepare as skins. Bats are exceedingly important, however, and offer more possibilities to the collector, probably, than any other order of mammals.

Only rarely may bats be trapped. Some of the fruit-eating species may be caught in traps set about ripe bananas, plan-

tains and other tropical fruits, but most of the specimens the collector secures must be shot while flying, or knocked down by sticks. Because bats ordinarily do not take wing until dusk, some of them much later, shooting must be done in uncertain light and with the added disadvantage that specimens actually hit are lost as they tumble out of the sky-line. The flight of bats is so irregular and erratic that they are extremely difficult targets and the collector must be a very good shot to get many with the gun. The best size of shot for shooting bats is No. 12, or No. 10 if they are flying high; and both the small auxiliary charge and the full size 16-gauge shell will be useful.

When bats are found in caves they are much more easily secured. Here a shot may be fired into a colony of them as they are at rest, and often one shell brings down all the specimens required. Perhaps the passages in a cave are low and will allow a collector to reach bats with sticks or switches, and specimens may be knocked down. Bats have the habit, often, of segregating themselves in caves by sex and species. That is to say, all the individuals of a cluster or colony will be one species and one sex. This means that a few specimens should be taken in each part of a large cave in order to be sure that a complete representation has been secured. After a shot or two has been fired in a cave the bats may take wing, and such a state of confusion reigns that the collector will have no way of telling what he is collecting until the specimen is in his hand.

A net may be stretched across the entrance to a cave and the bats driven out into it. Mosquito-bar or cheese-cloth may be used for this purpose. An insect-collecting net or butterfly-net occasionally comes in handy in cave collecting.

Some species like to fly back and forth over the water and are thus more easily found when shot because they fall into the water. If the water is still or slow-moving, and one is able to retrieve what he shoots, such a collecting site will

prove very valuable. Little clearings in the forest or open meadows will also be good places to watch for bats.

Bats may frequent dwellings or old buildings and are secured by much the same methods as are employed in caves, namely, shooting, knocking down by switches, or netting. Hollow trees in the forest may be the home of desirable species which can be smoked out by a fire and shot or netted as they emerge.

Some of the rarest species of bats are forest dwellers and spend the day hanging in thick clusters of leaves or where two or three leaves hang together to make a shady nook. Such dark spots are made when a banana or plantain leaf is broken across the mid-rib by the wind and hangs down, in shape like an inverted V. At the apex of the V there may be a bat or two and a shot may be fired at a venture with a fair chance of specimens, if the collector is in a good bat country.

Bats are skinned just as the chipmunk was skinned, page 26, but may be more troublesome at first because of their somewhat different body shape and the presence of wings. Be sure to break the wing at the humerus so that the elbow joint is left in the specimen, and when making up the skin remember to leave the elbow in a position to afford the measurement of the forearm, to be taken from the dried skin later.

No difficulties will be encountered in stuffing the skins of bats, but the collector may be troubled when he attempts to pin the specimens out to dry. Pin the bat out with the back up, belly to the board, just as with the chipmunk. Set the wings close to the body by a pin through the wrist, drawing the wrist close up to the neck and body. Bring the thumb with its sharp, tiny claw, back against the wing, so that it does not stick out to catch on things. The long finger joints or phalanges will tend to arrange themselves in a natural order, running backward from the wrist close together and parallel. A pin or two at the tips of the wings helps to hold the wings in place.

The hind legs are generally pinned farther apart than would

be the legs of a rodent, for example. This is to allow for a better display and arrangement of the interfemoral membrane which extends from leg to leg and may include the tail.

Instructions are given elsewhere for preserving bats as alcoholic specimens.

Miscellaneous Hints

After one has prepared a few small mammals, various short cuts in procedure may suggest themselves. Individual deviations from the practice described in this handbook may be worked out without detracting in any way from the satisfactory nature of the final result.

I find it easier to break the legs of small mammals with my fingers, thrust the broken end of the limb bone through the flesh, and strip the meat off, rather than to unjoint the legs.

Short wires may be cut for the legs. These wires are twisted into the filling for the leg, thrust into place and left there. This makes a very strong leg and is excellent practice.

In making up skins of rabbits and hares it will be necessary to use a long wire running from the toes of the forefoot to the toes of the hind foot. The skin of these animals is so delicate that the legs will break off unless such a wire is used. If one end of the wire is sharpened, it may be thrust clear through the forefoot far enough to allow the other end to be inserted into the hind leg.

It may be more convenient to remove the skin and clean the meat from the legs as a final process, cutting the legs free from the body with scissors at the moment of skinning.

If pressed for time, with many specimens to save, I often skin everything before beginning to stuff the specimens. This practice may save mammals on the verge of decomposition. The poisoned skins turned right side out are kept in a box or placed where they can not dry out too fast before they are stuffed.

The tails of some species will not strip readily from the vertebræ and must be split along the underside their entire length. This is true of the skunk and the porcupine.

MISCELLANEOUS DATA FOR LABELS OR NOTEBOOKS

All data of a nature not already well known, such as notes on food, life-histories, or details of soft structures which are not discernible in a dried skin, should be set down on the label, or in the field note-book if too voluminous for the small space available on the label. Facts that are known to be well established do not call for special notes, but it is well worth while to have some sort of record of even seemingly trivial data because we know so little of the life-histories of most of our small mammals.

Unless one is a specialist in such matters, it is difficult to identify stomach contents of small mammals while in the field. A specimen or two in alcohol, or simply the stomachs themselves in preserving fluid, may be saved for a later examination in the laboratory. However, it is often possible to discover what the mammals have been feeding on by an examination of food in mouth or cheek-pouches before it has been chewed into fine particles. Perhaps the food of a species can be discovered in its runways or burrows.

The condition of the sexual organs is worth noting, as this has a bearing on the breeding season. The number and stage of development of any fœtuses found should be noted on the label. If the mammary glands of a female show the animal is nursing, record it so on the back of the label.

Often the arrangement and number of the pads on the feet are different in closely allied forms, and it is of importance to know the condition of the plantar and palmar surfaces. In a dried specimen it may be impossible to make out from the shrunken foot whether the mammal had five or six plantar pads, for example. This is readily apparent if the animal is examined in the flesh and should be noted on the label if the specimen is suspected to be a rare or unknown species.

Many of the external characters of bats are either lost or so distorted in a dried specimen as to be of little value. Struc-

tures on the nose and ear especially should be examined and any peculiarities noted on the label or in the note-book. So important are these structures in identifying bats that it is highly desirable to save some of each species in alcohol or formaldehyde. A good rule is to save the first specimen of each distinct bat collected, as an alcoholic. Then if no more are secured the maximum amount of data can be obtained from the one specimen.

GUARDING AGAINST ANTS

Often in the tropics ants will prove decidedly troublesome and no very satisfactory methods have been evolved to escape them. Skins may be protected by naphthalene, paradichlorbenzene, or insect-powder, as has already been pointed out, but there is no way to keep ants from attacking the bait in the traps or the specimens caught by the traps.

Any substance placed upon the bait to render it unattractive to ants has an undesirable effect upon the appetites of the mammals one wishes to catch. If a trap-line can be run only once a day the ants may carry off all the bait before a mammal has the opportunity to visit the trap. If it is possible to rebait the traps late in the afternoon it is well worth while to do so.

The greatest damage done by the ants is upon the trapped mammal, which is sometimes injured beyond all hopes by the time the traps may be run in the morning. If the collector can visit part or all of his trap-lines about 9 or 10 o'clock in the evening, he can prevent the ravages of the ants from assuming such disastrous proportions. If the mammals could be trapped alive probably many of them would be able to fight the ants off, but it should be remembered that ants have been already attracted to the spot by the bait and are apt to devour a small creature in confinement. In any event, it is out of the question for the collector who is working

in out-of-the-way places to carry an extensive line of the bulky live-traps.

When doing the first collecting in a locality it is important to save the first specimen of each species taken, regardless of its condition. It may be the only one taken during the entire stay. Later, when damaged specimens of a species demonstrated to be common are taken, they may be discarded or made into skeletons. If the ants have attacked only the soft parts the specimen may still be perfectly satisfactory as a skeleton. It may be best to preserve an ant-damaged specimen in formaldehyde or alcohol, if a series of holes have been eaten in the skin.

A more extensive account of some of the points taken up in this handbook is given in "The Art of Taxidermy" by John Rowley, published by Appleton & Co., of New York City. A more recent and enlarged edition of this work is now on the press and will be published shortly. These books by Mr. Rowley are recommended without reservation.

MATERIAL TO BE SENT TO THE AMERICAN MUSEUM

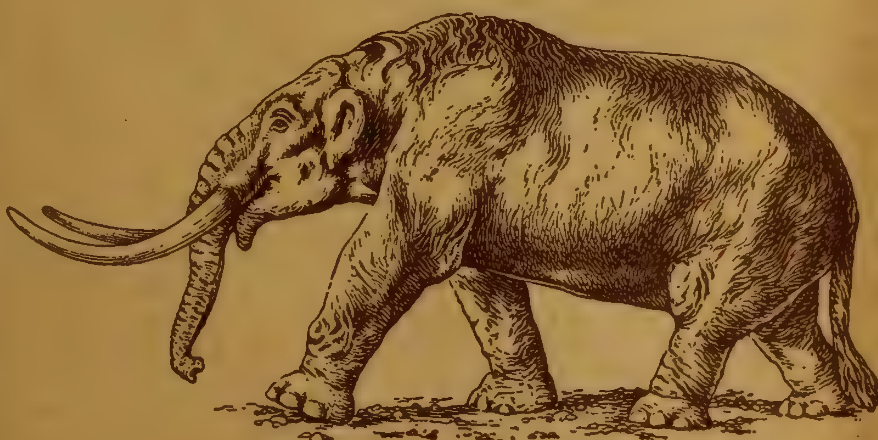
Mammal skins to be sent to the American Museum should be well dried, carefully packed in strong, tight boxes, with some substance like naphthalene to keep insects out, and shipped in such a manner that the specimens can not be damaged by heat or water. Sometimes boxes may be packed near to boilers on the steamer or left out on the deck. Either practice will be injurious to skins. Address the box plainly to

American Museum of Natural History,
New York City,
U. S. A.

Any questions of customs duties or entry into the United States will be taken up and arranged for by the American Museum.

THE AMERICAN MUSEUM OF NATURAL HISTORY

MASTODONS AND MAMMOTHS OF NORTH AMERICA



By HENRY FAIRFIELD OSBORN

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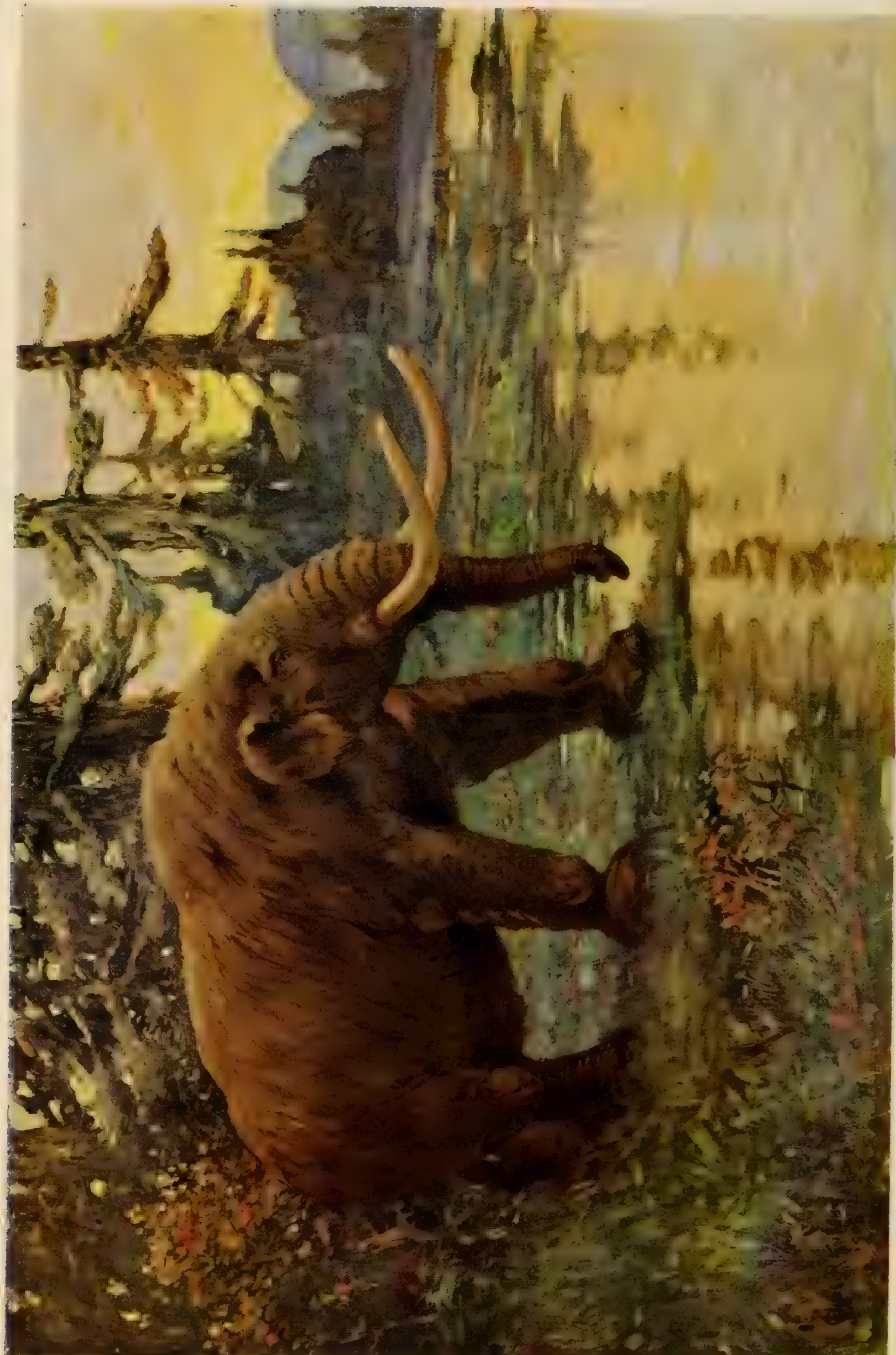

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Group of American mastodonts (*Mastodon americanus*) along the banks of the Ohio River, where these animals were first discovered in 1739. After restoration by Osborn and Knight.

The Elephants and Mastodonts Arrive in America

By HENRY FAIRFIELD OSBORN

President of The American Museum of Natural History

Foreword.—Among the treasures of the American Museum is the unrivaled collection of skeletons and skulls of fossil proboscideans from Africa, the home of the race, from Asia, and from North and South America. Aided by the Morgan and Jesup funds, a large volume is being prepared describing the whole history of the elephant and mastodont families as far as known today. The present article is a sketch of these remarkable animals as they migrated, one race after another, into America, became naturalized and acclimated, enjoyed their lives here, and finally became extinct, the last survivor being the great mastodon of the eastern forests of North America.

THERE are few joys in life comparable with that which the naturalist experiences when one of his predictions or prophecies happens to be fulfilled. In 1900 I predicted that Africa would prove to be the cradle of the Proboscidea: in 1903 this prophecy was verified by British explorers in Egypt. Naturally eager to visit the scene of this discovery at once, I refrained until my British friends had fully described and published this and other discoveries and gained the world-wide reputation therefor to which they were richly entitled. I then asked President Theodore Roosevelt for an introduction to Lord Cromer, at the time Viceroy of Egypt, and through the generosity of President Jesup of the American Museum an expedition was fitted out, carrying as credentials a thoroughly characteristic note from President Roosevelt to Lord Cromer. Unfortunately, I did not keep a copy of the note but, so far as I recall, it ran as follows:

January, 1907.

Dear Lord Cromer:

The bearer, Henry Fairfield Osborn, is a friend of mine keenly interested in palæontology who desires to enter the Fayûm district of Egypt. Any help which you may be able to extend to him or to his party will be greatly appreciated by

Yours sincerely,

Theodore Roosevelt.

This brief and simple diplomatic message opened the doors of Egypt to the American Museum party. On our arrival at Shepheard's Hotel on the morning of January 23, a card was sent up announcing Captain H. G. Lyons, then director of the Geological Survey of Egypt, who thereupon as-

sured me that all the resources of the Survey would be placed at our disposal,—a camel caravan, a supply of the absolutely essential *fantasses* for carrying water, and, best of all, the guidance of a most intelligent and delightful member of the Survey staff, Mr. Hartley T. Ferrar. A personal caravan was also engaged. Thus, sixty camels strong, we wound our way past the pyramids of the eastern side of the Nile, skirted the fertile basin of the Fayûm, and struck southwest into the waterless desert until we reached the region that represented the ancient cradle of the elephant family. We at once set to work with a very superior force of Egyptian excavators from Kuft, under the direction of Mr. Walter Granger and Mr. George Olsen, two of the best fossil hunters of America, who stuck to their arduous post for nearly two months, until driven out by sandstorms and excessive heat. With their skilled aid, we soon discovered the burial sites of three of the early elephant dynasties; the MŒRITHERIUM, the abundant PHIOMIA, and finally the rare PALÆOMASTODON. The last-mentioned name is derived from the uncorrupted Greek words παλαιός, μαστός, and ὀδούς, signifying "the ancient nipple tooth." This name, applied by the able British palæontologist, Charles W. Andrews, recently deceased, has proved to be of literal significance because we now have reason to believe that *Palæomastodon* may be the direct lineal ancestor of our true American mastodon (*Mastodon americanus*). Thus for the American Museum was disinterred a superb collection of small ancestral mastodonts, remote and humble relatives of three branches of the mastodont family—all of Upper Oligocene time, estimated by some geologists as 3,000,000 years ago.

The Fayûm Expedition took place seventeen years ago. It aroused in the writer's mind the liveliest interest in these relatively small and primitive proboscideans, and a desire to compare them closely with the large proboscideans of France and South America, which were first described in 1806 by the famous Cuvier, also the wish to compare them with the proboscideans described and figured by the British explorers Falconer and Cautley in India between the years 1845 and 1847, and finally the hope to trace all these animals from their ancestral homes in Africa and Eurasia through their migrations to America.

TRAVELING INSTINCTS OF THE PROBOSCIDEANS

An insatiable *Wanderlust* has always possessed the souls of elephants as it has those of the tribes and races of man. Not only to overcome the changes and chances of this mortal life, but also to gratify their intelligent curiosity ever to explore afresh forests, pastures, fields, rivers, and streams, they have gone to the very ends of the earth and have far surpassed man in adapting their clothing and teeth to all possible conditions of life. Thus the romances of elephant migration and conquest are second only to the romances of human migration and conquest. Variety is the spice of elephant life, as it is of human life, and the very longing for a change of scene and of diet has been the indirect cause of what in scientific parlance we term *adaptive radiation*—the reaching out in every direction for every kind of food, every kind of habitat, in itself the *cause* of radiating or divergent evolution and adaptation. It is to this predisposition to local, con-

tinental or insular, and world-wide wanderings that we attribute the many branches and sub-branches which have been developed in this remarkable family. We may first enumerate all these branches and then signalize those that found their way to America and which form the chief subject of this article.

PROBOSCIDEA

Races I–X of the Mastodont Family: Mastodontidæ

I. The Mœritheres, named from Lake Mœris of the Greeks. Small amphibious mastodonts of the North African rivers and lakes. See figure p. 9.[1]

II. The Dinotheres, implying proboscideans of terrifying size. Existed in Europe and Asia in Miocene and early Pliocene times.

III. The True Mastodonts, arising from *Palæomastodon* of the Egyptian Oligocene. Sparsely represented in the forest and lignitic deposits of Europe; first appearing in America in Upper Miocene time, becoming the giant mastodons of the American forests at the close of the Ice Age. See figure p. 12.

IV. The Yoke-toothed Mastodonts, or Zygolophodonts. First known in the Miocene of Europe and leading into Borson's mastodon of the Upper Pliocene forests of Europe and Asia, close to the true mastodonts.

V. The Long-jawed Mastodonts, or Longirostrines, springing from the long-jawed *Phiomia* of the Egyptian Oligocene and becoming the *Trilophodon* of Europe, migrating through Europe and Asia in the Miocene and spreading over Nebraska, Kansas, South Dakota, and Colorado in Pliocene time. See figures pp. 10 and 11.

VI. The Tetralophodonts, the name referring to the four ridge crests on the anterior molar teeth. First known from the Lower Pliocene of Eppelsheim, Germany, and of Pikermi, Greece; migrated across India, and entered America in late Pliocene time during the beginning of the Ice Age.

VII. The Serridentines, named in allusion to the serrations on the outer and inner borders of the grinding teeth; medium-jawed. First known in the Miocene forest deposits of Europe; migrated to our southern states, Texas and Florida, and survived to the very close of Pliocene time. See figure p. 13.

VIII. The Beak-jawed Mastodonts, or Rhynchorostrines, readily distinguished by the downward curvature of the tusks, similar to that in the Dinotheres. Of unknown European origin; first discovered in Colorado and California, and traced down into Mexico.

IX. The Nototostrines, name signifying 'mastodonts of the south' because the animals are found chiefly in California and South America. Short-jawed, the like true mastodons.

X. Extremely Short-jawed Mastodonts, or Brevirostrines. First known species, the straight-tusked mastodont of Auvergne, Pliocene of France. The Brevirostrines migrated to India, reached western Nebraska in Middle Pliocene time, and survived in our southern states into the beginning of the Ice Age. See figures, p. 15.

Races XI–XVI of the Elephant Family: Elephantidæ

XI. The Stegodonts, named because of the resemblance of the toothed rodges of the grinding teeth to a series of roof-gables are more primitive than the true elephants. The Stegodonts have been traced from the Miocene of Europe into the forests of India and the Eats Indies to China.

XII. The African Elephants, or Loxodonts, distinguished by their lozenge-shaped grinders. See upper figure p. 18. Related forms attained gigantic size in southern Europe and in India, dwarfing into the diminutive species of the Mediterranean islands. See lower figure p. 6.

XIII. The Southern Mammoths (*Archidiskodon*, signifying ancient crested). First known in India, migrating westward into southern Europe, eastward by Bering Strait into America, where they arrived in early Glacial time, and gave rise to the imperial mammoth. See figure p. 20.

[1]The series of illustrations throughout the article are all to a uniform scale, with the exception of the headpiece and tailpiece.

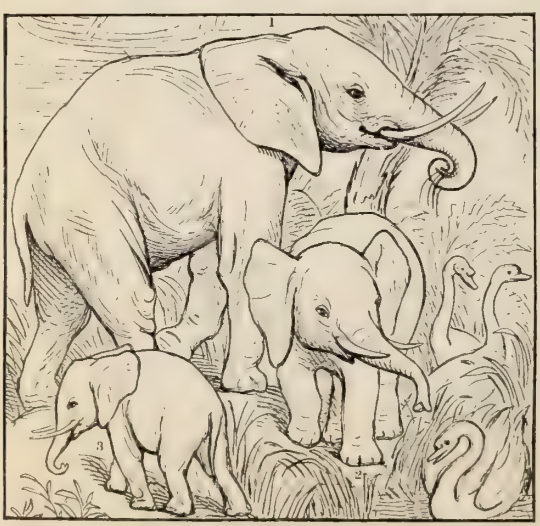
XIV. Parelephas, signifying a collateral to the true *Elephas*. Mammoths of the temperate zone. First known in Europe, traced into America, where they arrived in mid-Glacial time, and gave rise to the great Jeffersonian mammoth.

XV. The Woolly Mammoth (the *Elephas primigenius* of Blumenbach). First discovered in northern Germany and in England. It crossed northern Asia, and arrived in America in late Glacial time. See figure p. 21.

XVI. The True Elephants (the *Elephas* of Linnæus), probably originating in northern Asia. First known in India early in the Age of Man, and giving rise to the recent species of India, Burma, and Ceylon. See lower figure p. 18.

African home of the primitive mastodonts.—The word "Proboscidea" as printed 1900 and supplemented in the present map by the black dot (●) indicates the Fayûm Desert of Egypt, where these animals were discovered in 1903

So strong was the migratory impulse that only six out of these sixteen races of mastodonts and elephants failed to reach America. The Stegodonts (Race XI), one of these six groups of 'stay-at-homes,' were confined, according to the writer's theory, to the warm southern forests of India, to China, Japan, and the East Indies, when these islands were connected with the mainland. The true African elephants, or Loxodonts (Race XII), never left the African continent, although the somewhat closely related pygmy elephants of the Mediterranean islands (see lower figure on this page) and the giant straight-tusked elephants of India and southern Europe were great travelers. The true Indian elephant (Race XVI) never went beyond the confines of Asia, and its Asiatic ancestors still await discovery; their probable home land was in the great northern plateaus and forests. The amphibious Mœritheres (Race I) were closely bound by their river habitat to Africa and thus far have not been recognized elsewhere. The Dinotheres (Race II), notwithstanding their long limbs and gigantic size, wandered only east and west in their European and Asiatic homelands. The 'yoke-toothed



Pygmy elephants of Malta and of the other Mediterranean islands, as restored by Leith Adams in 1870, namely, 1, *Loxodonta* (*Pilgrimia*) *mnaidra;* 2, *L.* (*Pilgrimia*) *melitensis;* and 3, *L.* (*Pilgrimia*) *falconeri*, the smallest $\frac{1}{50}$ natural size

Theoretic migration routes of the mostodont family from their center (•) in Africa to all of the continents excepting Australia. The cradle of the elephant family is still unknown

Actual migration routes of the long-jawed mastodonts (Longirostrinæ) and of the true mastodon (Mastodontine) from their actual center of origin in north Africa as indicated by their respective symbols. Note also the migration routes of the Brevirostrines, Notorostrines, and Rhynchorostrines

mastodonts,' or Zygolophodonts (Race IV), never reached America and are not treated fully in this article.

The successive times of departure and arrival of the ten wandering races as contrasted with the 'stay-at-homes

cannot be fixed exactly. En route from Asia to North America, they were all forced to come by way of the northern Bering Strait, then an isthmus. Some races, like the 'beak-jawed mastodonts,' are very rare and are as yet known only by a few specimens, which are of highly characteristic and easily distinguishable form and associated habit. All the arrivals were naturally subsequent to the early evolution of the sixteen races of proboscideans in the African and Eurasiatic continents. In some cases the migrations appear to have been gradual; for example, the 'long-jawed mastodonts' (Race V), as represented by *Phiomia*, appear in the Oligocene of Egypt; they spread all over Europe in Miocene time, and were fairly abundant in Nebraska and Colorado in Pliocene time. At the other extreme are such instances of rapid traveling as that represented by the southern mammoth, which appears in the Upper Pliocene of Europe and in the advancing Ice Age of North America. Next in point of interest is the evidence of strong climatic preferences; it would appear that the south temperate and north temperate races of elephants sought corresponding and congenial life zones for their prevailing habitat, as do the Italians, the Germans, and the Scandinavians in the human migrations of our day.

Thus three kinds of mammoths are distributed on different isotherms, as indicated in the table herwith.

Proboscideans have always been fastidious in their feeding habits. Consistent with their choice of similar isotherms conditioning the flora and fauna of their times, these clever animals coming from the Old World also sought out similar habitats in America, whether of northern or southern forests, savannas, stream borders, or more or less arid and desert zones. For example, we have proof of the arrival of Race X (the Brevirostrines, genus *Stegomastodon*) in the rapidly desiccating areas of western Texas and western Arizona, where they competed for food with other desert-loving forms, like the horses, the camels, and the armored glyptodonts (*Glyptotherium*) of South America. Superb adaptations to these different degrees of temperature, different kinds of food, and more or less moist or arid atmosphere appear not only in the tusks and in the grinding teeth (which are beautifully preserved in the fossil condition), but also doubtless in the unique shaping of the upper lip into the organ known as the proboscis, which gives these animals their ordinal name Proboscidea.

RACE I, THE MŒRITHERES, AND RACE II, THE DINOTHERES

THE MŒRITHERES (RACE I).—These are the oldest proboscideans known at present, the most primitive and diminutive. Their remains occur in the estuarine and fluviatile sands of the primordial river Nile, which the German geologist, Blanckenhorn, named 'Ur-Nile.' The pair of enlarged upper and lower tusks abrade each other as in the hippopotami; were it not for the fact that these teeth are comparable to the pair of incisors

CLIMATIC TABLE

Kinds of Mammoths	Eurasia	America
XV. WOOLLY MAMMOTH	Boreal and circumpolar habitat	Boreal habitat and borders of glacial ice sheet
XIV. TROGONTHERIAN MAMMOTH (*Parelephas*)	Mid-temperate regions	Mid-temperate regions
XIII. SOUTHERN MAMMOTHS	South temperate: *Elephas meridionalis*	South temperate: imperial mammoth (*Elephas imperator*)

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Mœritherium on the borders of the primitive river Nile, now the Fayûm of Egypt. After restoration (1907) by Osborn and Knight; 1/50 natural size

enlarged into tusks in all other proboscideans, and that the grinding teeth are also comparable to the grinders of all the higher mastodonts, we might question the relationship of these animals to the higher proboscideans, because their amphibious habits separate them so markedly from the other members of their order. They disported abundantly in the Ur-Nile but are not known to have migrated into Europe or to have left descendants.

THE DINOTHERES (RACE II).—Teeth, jaw fragments, and an astragalus of the Dinotheres had been found and described between the years 1715 and 1758, but it was not until 1828 that the famous lower jaw, named by Kaup in 1829 *Dinotherium giganteum*, was discovered at Eppelsheim, Germany. The Dinotheres appear abundantly in the Miocene of Europe and we are inclined to believe that they sprang from African ancestors, because one of these ancestors has recently been discovered.[1] As they are distinguished by sharply crested teeth and by a pair of huge down-turned lower incisive tusks, it was long supposed that, like the Mœritheres, they too were amphibious in habit, but this hypothesis has been weakened by the discovery of a complete skeleton, which shows that these proboscideans had very tall limbs, with high body proportions altogether different from those of the Mœritheres and of the existing hippopotami; in fact, all amphibious mammals have either short limbs or no limbs at all. Whatever their habits and special habitat, the Dinotheres attained gigantic size, as evidenced by the *Dinotherium gigantissimum* of Roumania. They reached India, but thus far there is no evidence of their having penetrated as far as China and still less of their having approached the American continent.

[1]This is *Dinotherium hobleyi* from the east side of Victoria Nyanza, described in 1911 by the late Charles W. Andrews, of the British Museum, found in beds attributed to Lower or Middle Miocene age.

RACES V AND III. THE LONG-JAWED MASTODONTS AND THE TRUE MASTODONS

THE LONG-JAWED MASTODONTS (RACE V).—These animals derive their scientific name 'Longirostrines' from their extremely long and slender jaws, which far surpass in length those of any other land mammal thus far discovered. At the extremity of the lower jaw is a pair of shovel-shaped lower tusks, and there is no doubt that these tusks were used, after the manner of a trowel or spade, in the digging out and uprooting of plants. That this unique function gave these animals very great advantage over their rivals is demonstrated by the rapid spread of the Longirostrines eastward into India, thence northward into China and America, and all the while they were increasing in size and power until as a culmination the massive animal known as *Tri-*

lophodon giganteus, discovered by Mr. Troxell in South Dakota, attains a height nearly equaling that of our giant American mastodon. It is difficult to believe that this giant springs from the relatively slender North African Longirostrine, to which the name *Phiomia* has been given in reference to the proximity of its former habitat to the Fayüm of Egypt, the Phiomia of the Greeks; yet when we examine minutely the horizontally placed upper and lower tusks of *Phiomia*, the long narrow grinding teeth harmonic with the long jaw, and the three crests of the intermediate grinding teeth, there can be little doubt that *Phiomia osborni* is a progenitor of the race that gave rise to the *Trilophodon angustidens* of Europe, to the *Trilophodon palæindicus* of India, and to the numerous long-jawed species recently discovered in South Dakota, Nebraska, and Colorado by condition, hardly more complex than those of the Egyptian *Phiomia*, in which the jaw measures two feet six inches. To our mind, the Longirostrine relied very largely upon their superior and inferior tusks for the gathering in of food, which was rapidly masticated and readily swallowed because of its relatively succulent nature.

THE TRUE MASTODONS (RACE III).—The true mastodons of our American forests appear to have arisen from the diminutive *Palæomastodon* of the primordial river Nile. The reason these animals have left no trace of their 10,000-mile and 2,000,000-year journey from the Nile region to the forests bordering the Ohio and the Hudson rivers is that fossilization of forest-living fauna has always been rare. The ancestral *Palæomastodon* of the Nile region is itself very rare; in the American Museum collection there are

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Long-jawed mastodont (*Phiomia osborni*) on the borders of the primitive river Nile, now the Fayûm of Egypt. After restoration by Osborn and Knight; 1/50 natural size

Prof. Erwin H. Barbour of the University of Nebraska, by Mr. Harold Cook of western Nebraska, and by Mr. E. L. Troxell mentioned above.

In these American Longirostrines the elongation of the lower jaw and tusks reaches the incredible extreme of six feet, seven inches in the species *Trilophodon lulli*. Jealous of her endowments, nature kept the grinding teeth of these animals in very simple

forty-eight specimens of the long-jawed *Phiomia* to seven specimens of *Palæomastodon;* not even fossilized teeth of this race were scattered in Europe to show the route. Thus, while the woolly mammoth left an overwhelming number of fossilized remains which were discovered in western Europe from the end of the eighteenth century onward, the true mastodon was first found on the banks of the Hud-

Long-jawed mastodonts (*Trilophodon giganteus*) from the Lower Pliocene beds of South Dakota. After restoration by Osborn and Knight; 1/50 natural size

son (1705) and the Ohio (1739). The Ohio fossils were fully characterized by the great French naturalist Buffon as a distinct species belonging to the epoch of the elephants although Buffon did not give the animal a name. Johann Friedrich Blumenbach, who named the woolly mammoth *Elephas primigenius* in 1799, in the same communication placed the name OHIO-INCOGNITUM beneath the figure of the tooth of the American mastodon. These animals now rival the mammoth, as the best-known of all the extinct proboscideans; thousands of teeth and jaws, as well as more or less complete skeletons have been found, chiefly in the Fourth Glacial swamps and marshes of our Middle and Eastern States.

In contrast with the long-jawed mastodonts, the true mastodons are short-jawed. Their lower tusks are

True mastodon (*Mastodon americanus*) from the Pleistocene beds of New York. After restoration by Osborn and Knight; $\frac{1}{50}$ natural size

variable; the upper tusks curve upwards and inwards, like those of the elephants, and served for uprooting plants and for defensive and offensive purposes, while the proboscis was the main 'food getter' for the huge bodily frame.

RACES VI, VII, AND VIII. TETRALOPHODONTS, SERRIDENTINES, AND BEAK-JAWED MASTODONTS

THE FOUR-CRESTED MASTODONTS (RACE VI).—In 1832 Europe was greatly stirred by the discovery in the Lower Pliocene of Eppelsheim, Germany, of a mastodont with *four* instead of *three* ridge crests on its intermediate grinding teeth. Hugh Falconer based upon this character the appropriate name *Tetralophodon* (i.e. four-crested teeth) as distinguished from *Trilophodon,* the designation of the mastodonts with three ridge crests. In these animals with four-crested teeth the jaws are not so extremely elongated for shovel and spade work as in the long-jawed mastodonts (Race V), but by way of compensation, the grinding teeth became much more complex because they had to do far more work. While the back grinders of the long-jawed mastodonts remain very simple and never exceed four and a half ridge crests, the back grinders of the Tetralophodonts rise to seven and a half ridge crests and become adapted to their very long and arduous life work, culminating in the stage which the writer has named *Tetralophodon* (*Morillia*) *barbouri*, after Dr. Erwin H. Barbour, the geologist and explorer, and the Honorable Charles H. Morrill, patron and benefactor of the exploration of the extinct life of Nebraska. The Tetralophodonts are in all coun-

tries very rare, yet we can trace their long migration through eastern Europe into India and China, until finally they arrive in Kansas and Nebraska. The jaws remain of medium length, the lower tusk is not as yet known; the upper tusk curves downwards and outwards.

THE SERRIDENTINES (RACE VII).—The Serridentines, or 'serrate-toothed mastodonts,' have only recently, as a result of investigations of the writer, become distinguished from the long-jawed mastodonts, on the basis of the structure of the relatively few teeth found in ancient forest or lignitic deposits of France, Switzerland, and Austria. Yet these few teeth afford indubitable proof that these Serridentines are not to be confused either with the long-jawed mastodonts (=*Trilophodon*) or with the medium-jawed mastodonts (=*Tetralophodon*). They form a race of their own, to which the generic name *Serridentinus* has been given. En route to America one member of this race succumbed and left his jaw to become a fossil on one of the ancient rivers of Mongolia, and here 2t was unearthed by the Third Asiatic Expedition in 1922 and subsequently christened *Serridentinus mongoliensis*. Eight thousand miles eastward and southward of this spot, which is in the desert of Gobi, the Americanized descendants are fouud in the marls near Santa Fé, New Mexico, and in the ancient river sands near Clarendon, Texas, in a formation of Lower Pliocene age. A beautiful restoration, made under the direction of the writer, from a nearly complete skeleton of a Serridentine of northern Texas is reproduced above. It shows the animal reaching for foliage with its proboscis, aided by a lower jaw with tusks of medium length, a jaw more elongate than in the true mastodons but less elongate than in the extremely long-jawed forms.

Serrate-toothed mastodont (*Serridentinus productus*) tree-browsing; as found fossil near Clarendon in northern Texas. After restoration by Osborn and Knight; natural size

THE BEAK-JAWED MASTODONTS (RACE VIII).—The 'beak-jawed mas-

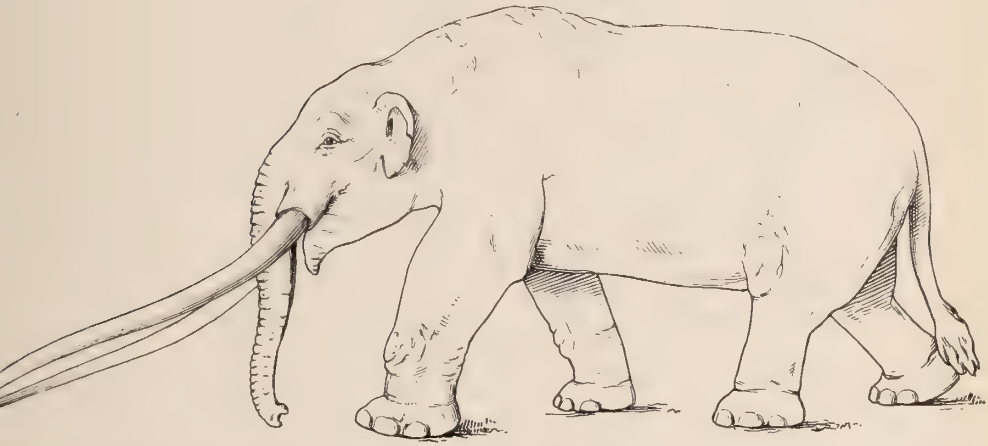
todonts,' technically known as Rhynchorostrines, are readily distinguished from all other mastodonts by the sharp downward curvature of the anterior portion of the jaw into a beaklike prolongation, in which are inserted two downwardly pointed tusks flattened on the sides. It was due to this unique adaptation of the jaw and tusks for uprooting plants and roots that Falconer in 1856–68 applied the name *Rhynchotherium* to the animal under the following circumstances: "At Genoa I saw a cast of a large lower jaw of a Mastodon from Mexico, with an enormous *bec* abruptly deflected downwards and containing one very large lower incisor. The beak is much thicker than in *M.* (*Trilophodon*) *angustidens* and larger than in *M.* (*Tetralophodon*) *longirostris*. You know that every one (Laurillard, Gervais, etc.) has insisted on the absence of the lower incisors from both of the South American species. The outline of the jaw resembles very much the figure in Alcide D'Orbigny's Voyage, described by Laurillard as *M. Andium*. The specimen is unpublished material and I was therefore only allowed to examine it very cursorily. The Genoese palæontologists had provisionally named it *Rhynchotherium*, from the enormous development of the beak, approaching Dinotherium."

Very few remains of this 'beak-jawed mastodont' have been discovered, and it has required long study to work out the peculiar adaptations of the dentition which consists of downturned upper and lower tusks and of very broad and simple upper and lower grinding teeth. Traces of the 'beak-jawed mastodonts' occur in Oregon in Montana, in Colorado, and in California, but thus far the best-preserved jaws are those from Mexico, the region from which came the specimen that the keen eye of Falconer first recognized as a beak-jawed animal quite distinct from the 'long-jawed mastodont' of western Europe.

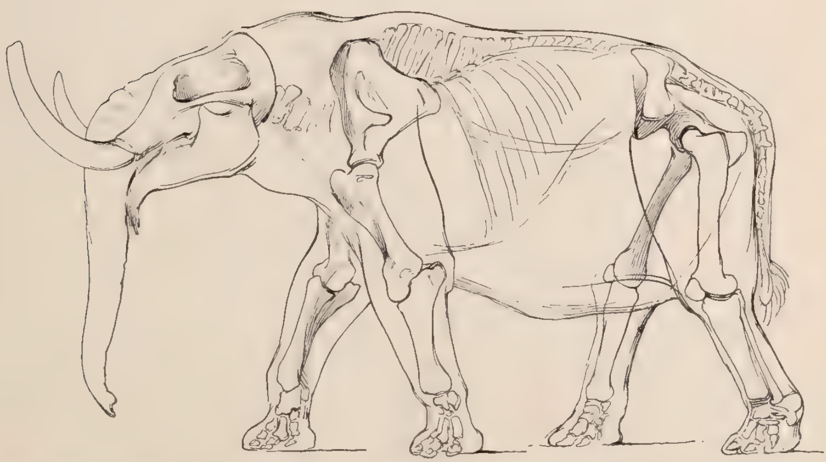
RACE X. THE SHORT-JAWED BREVIROSTRINES, AND RACE IX, THE NOTOROSTRINES

Races X and IX present a marked contrast to all the races preceding, in the shortening of the lower jaw and the disappearance of the lower tusks, which transfer to the upper tusks, the proboscis, and the upper and lower grinding teeth the whole function of collecting the food and of masticating it before it enters the long process of digestion and assimilation whereby the relatively feeble energy of plant life is transformed into the commanding energy of these proboscideans.

The back grinders, or third upper and lower molars, are, on the whole, the most characteristic part of the entire anatomy of these and other proboscideans, even more distinctive than the tusks. Many proboscideans resemble each other in the general shape of the superior tusks, which may display substantially the same curvature and shape in nine of the sixteen races which are here considered; this tendency is due to the fact that in all these races the upper tusks perform the same functions of offense and defense and are tools of great value in the uprooting of plants and small trees. It is true that there are in the tusks distinct differences of curvature and of diameter which become increasingly apparent as the animals attain old age, but the tusks of the young of the Indian elephants, of the woolly mammoth, of the Jeffersonian and of the imperial mammoths, of the African elephants, and of the Stegodonts are not readily distinguishable from the upper tusks of the true mastodons nor from the two tusks of the short-jawed



Short-jawed mastodont of southern Arizona (*Stegomastodon arizonæ* Gidley), as discovered by J. W. Gidley in the San Pedro beds. After restoration by Knight; 1/50 natural size



Short-jawed mastodont of Auvergne, France, (*Ananceus arvernensis*), highly characteristic of the Upper Pliocene of Italy, southern France, and Great Britain. After restoration by Osborn and Knight; 1/50 natural size

races we are now considering, namely, the Brevirostrines, the European and American genera of which are illustrated on p. 15, and the Notorostrines.

To distinguish clearly the sixteen races of proboscideans from one another we must study the back grinders with extreme care, and observe that these grinders are constantly changing their form to compensate for the gains and losses in the anterior grinders and in the upper and lower tusks. Thus, while the external appearance of the Brevirostrines and Notorostrines is not wholly dissimilar, the structure of the back grinders is radically at variance in the two races, and a very tyro in odontography could not fail to distinguish these grinders.

THE BREVIROSTRINES (RACE X).—Very early in their history the Brevirostrines began to lose their lower tusks with the rapid shortening of the lower jaws; in recognition of these changes, one of the first of these fossils found in France was termed '*Mastodon brevirostris*,' or 'short-jawed mastodont.' As in all other proboscideans ,the two compensations were, first, a great increase in size of the upper tusks, which became excessively long and straight in the mastodont of Auvergne, France, and short and massive in the mastodont of Arizona (see figures, p. 15), and, second, a novel and complex mechanism which developed in the back grinders. The first step in this new food-grinding adaptation is seen in the Brevirostrine of Auvergne (*Anancus arvernensis*) and in its distant cousin of India (*Pentalophodon sivalensis*), namely, a twisting of the outer and inner grinding-tooth cones so that they *alternate on the inner and outer sides of the teeth.* Meanwhile in the Indian *Pentalophodon* five ridge crests are added to the teeth in front of the back grinders, and the crowns of the back grinders are heightened. These two new devices in grinding-tooth construction were so successful that these animals increased in numbers in Eurasia and achieved their long journey to North America, where they first appear in western Nebraska, subsequently spreading southward into Texas and Arizona. The veteran palæontologist, Joseph Leidy, was so impressed with the complexity of these Brevirostrine grinding teeth that he thought the animal that bore them worthy of the name *Mastodon mirificus,* signifying the 'wonderful mastodon.' This complexity went on increasing by the addition and complication of the enamel foldings until the crown became a veritable labyrinth of dental tissue, well adapted to the hard grasses and tough woody fiber of the plants then becoming characteristic of the great American desert. It is by this condition of the teeth, ever growing more and more complex, that we trace these animals southward through the species *Stegomastodon* (*Mastodon*) *mirificus* of Nebraska into the *S. texanus* of Texas, thence into the *S. arizonæ* of the ancient playa lakes of Arizona, and finally into the giant *S. aftoniæ* of the First Interglacial epoch of Iowa.

Thus, this long and eventful journey from the Auvergne region of France, and the Norfolk region of England, through India, into the American desert, was rendered possible only by the constant evolution and improvement of the grinding teeth until they attained the highest degree of perfection of their kind.

THE NOTOROSTRINES (RACE IX).—These animals take their name from the Latinized Greek word *Nŏtus*, signifying the south wind, that blew upon them as they left southern California, where their remains have recently been discovered by Mr. Childs Frick, and

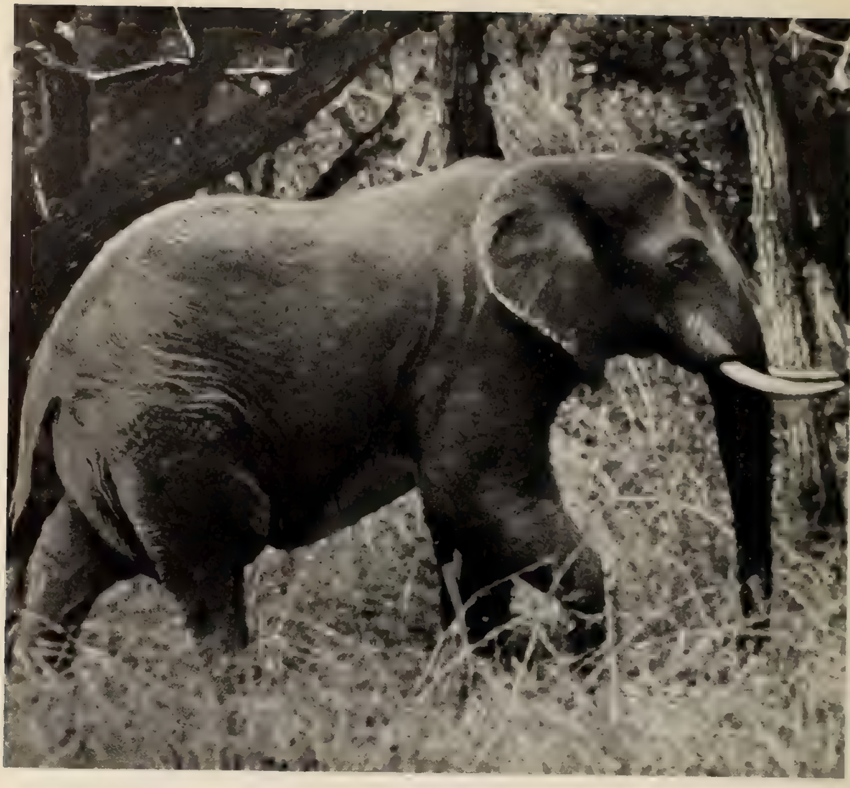
journeyed southward along the Andes to the region now known as the Argentine. As discovered in Neogæa, or South America, it was appropriate that Cuvier should name one of these species *Mastodon humboldtii*, in reference to the travels of Alexander von Humboldt, and the other, *Mastodon andium*, commemorating the discovery of remains of this species on the slopes of the Andes.

In these Notorostrines the lower jaws are in process of abbreviation with corresponding loss of the lower incisive tusks, an abbreviation which does not go so fast or so far as in the extremely short-jawed Brevirostrines just described. The superior tusks contain a long ribbon of enamel on the outer side, and as the tusk rotates on its own axis, this enamel ribbon is carried around to the inner side in a corkscrew spiral form, a peculiarity not observed in any other proboscidean. This powerful tusk was so effective that, again following her principle of economy, nature kept the back grinders in a relatively simple condition in the species now known as *Dibelodon* (*Mastodon*) *andium*, In its sister form, *Cuvieronius* (*Mastodon*) *humboldtii*, named in honor of both Cuvier and von Humboldt, the upper tusks are of simpler upturned form, without the enamel ribbon, and the grinding teeth at once become more complex by means of the enamel foldings known as double trefoils.

RACES XII AND XVI, THE LIVING ELEPHANTS, AND RACE XI, THE STEGODONTS

THE LIVING ELEPHANTS (RACES XII AND XVI).—We now turn to the history of the elephant family, Elephantidæ, the second great division of the proboscideans, the two living examples of which are the true elephants of India belonging to the genus *Elephas* of Linnæus, and the elephants of Africa belonging to the genus *Loxodonta* of Cuvier. We know nothing of the direct ancestral history, or of the immediate ancestors, of either *Elephas* or *Loxodonta;* this history still lies buried in the rocks of the great Eurasiatic continent north of India and in the vast unexplored strata of central Africa, but we look forward confidently to the filling in of these missing chapters in proboscidean history. As our knowledge stands at present, the Indian elephant suddenly appears fully formed during the Age of Man and the same is true of the African elephant. Attempts to establish the descent of the Indian or African races either from Race XI (the Stegodonts) or from Races XIII–XV (the Mammoths) will not stand the test of the higher criticism of palæontologists. Yet it appears certain that all the elephants sprang from ancestors like the Stegodonts.

THE STEGODONTS (RACE XI).—From Miocene to Pleistocene time, these very primitive elephants known as Stegodonts were dwellers in the tropical forests, extending from India and the East Indies to China. Differing from the mastodont family, the Stegodonts have a new kind of grinding tooth with multiple ridge crests, from which the grinding teeth of all the higher elephant races may have been derived, and it is not improbable that a certain branch of the Stegodont family wandered into northern Asia and was there transformed into some of the primitive members of the elephant family; such transformation certainly did not occur in southern Asia, where the Stegodonts have their own independent history that culminated in the prodigious and widespread Stegodontines, which left their fossil remains in the same deposits with the earliest of the mammoths. The best-known among these giant Stego-



Living African elephant (*Loxodonta africana* in the forests of Central Africa After photograph by Carl E. Akeley; 1/50 natural size

Courtesy of New York Zoological Society

Living Indian elephant (*Elephas indicus*) and living dwarf Congo elephant (*Loxodonta africana pumilio*) in the New York Zoological Park. After photograph by Elwin R. Sanborn; 1/50 natural size

donts is the species *Stegodon ganesa*, named after one of the legendary deities of India. It is contemporary with a giant true elephant related to the African.

THE THREE RACES OF MAMMOTHS (XIII, XIV, XV) WHICH REACHED AMERICA

The name *Mammut*, probably derived from the Tartar *mama*, signifying earth, in allusion to the discovery of fossilized bones buried in the earth, properly belongs to the northern or woolly mammoth, *Elephas primigenius*, the primordial elephant. The term mammoth is used in the present article in a much broader significance to embrace three great branches of the elephant family. Two of them—the imperial mammoth and the Jeffersonian mammoth,—resemble the woolly mammoth in the architecture of the cranium and in the strong incurvature of the superior tusks, as greatly as they differ from this boreal elephant in the structure of the grinding teeth. The cranium rises into a high acute peak and the forehead is concave instead of being plane and flattened as in the African elephant, or prominent and dome like as in the Indian elephant (see upper and lower figures respectively, p. 18). There are many other features which unite the three races of mammoths among themselves and which separate them from the African and Indian elephants, but the one of paramount interest to us is that these animals were greater wanderers than either the Indian or African elephants and successively entered the American continent as follows:

The imperial mammoth (Race XIII), late in the Age of Mammals, early in the Age of Man.

The Jeffersonian mammoth (Race XIV) during the Age of Man.

The woolly mammoth (Race XV), late in the Age of Man, during the period of the last great glaciation.

THE IMPERIAL MAMMOTH (RACE XIII).—This majestic animal was discovered by Ferdinand Hayden, the exploring geologist, in Nebraska, and described by Joseph Leidy in 1858 as *Elephas imperator*, signifying the 'imperial elephant' in reference to the surpassing size of the grinding teeth and the impressive height of the animal. This designation has been more than justified by subsequent discoveries of remains of this gigantic animal in Nebraska, Kansas, Iowa, Texas, California, and Mexico, consisting of portions of teeth, skulls, and skeletons sufficient to establish the fact that the full-grown animals attained a height of 13½ to 14 feet, exceeding by 2½ feet the tallest of the existing African elephants and rivaled only by the gigantic straight-tusked elephant of India and western Europe known as *Loxodonta antiqua*.

The grinding teeth are readily distinguished by their surpassing size and by the relative paucity of the enamel ridge plates, which never exceed twenty in number; the ridge plates are very far apart and the enamel bands are broad, whereas in the woolly mammoth the enamel of the ridge plates is excessively fine, the grinding teeth are relatively small, and the numebr of ridge plates amounts to twenty-seven. It is in reference to this massive but primitive structure of the grinding teeth that Prof. Pohlig has named these animals *Archidiskodon*, signifying primitive ridge plates. The adaptation of these huge, coarse grinders was to tree-and shrub-browsing and the crushing of great masses of leaves and twigs; these imperial mammoths were therefore probably browsers, and with the reduction and disappearance of the western forests, they diminished in numbers and became extinct—the last of a noble line which traces its lineage

IMPERIAL MAMMOTH (*ARCHIDISKODON IMPERATOR*) OF NEBRASKA AND TEXAS. AFTER RESTORATION BY OSBORN AND KNIGHT; 1/50 NATURAL SIZE

WOOLLY MAMMOTH (*MAMMONTEUS PRIMIGENIUS*) OF THE RIVER SOMME, FRANCE, IN LATE GLACIAL TIME. AFTER RESTORATION BY OSBORN AND KNIGHT; 1/50 NATURAL SIZE

back to *Archidiskodon planifrons* in the Upper Pliocene of India and is related to the giant *Archidiskodon meridionalis* of the Pliocene and Lower Pleistocene forests of Italy, France, and Great Britain. In America *Archidiskodon* attained by far its greatest size, as majestically represented in our restoration (p. 20).

THE JEFFERSONIAN MAMMOTH (RACE XIV).—It has taken many years of study to disentangle the lineage of this great immigrant from that of the imperial mammoth on the one hand and that of the woolly mammoth on the other. With the aid of Prof. Hans Pohlig of Bonn and of Prof. Charles Depéret of the University of Lyons this lineage has been traced back to Germany, to southern France, and to Great Britain, and it is now a well established fact that the Jeffersonian mammoth came from smaller and more primitive ancestors which wandered in the forests and meadows of western Europe during the first half of the Age of Man. These European forebears replaced the ancestors of the imperial mammoth and were in turn replaced by great herds of the woolly mammoth that entered Europe in the closing period of the Age of Man. These animals are so distinct from either the imperial or the woolly mammoth stock that we give them the separate generic designation of *Parelephas*, in allusion to their development parallel with the true elephants of India. Whereas the European branch of *Parelephas* became extinct, the American branch flourished exceedingly in the temperate regions of the United States, and its fossil remains are far more numerous than those of either the imperial or the woolly mammoth; *Parelephas* also endured for a long period of time and underwent a considerable evolution in respect to its grinding teeth, from an earlier stage which we have named *Parelephas jeffersonii* in honor of President Jefferson, to a final stage in which the third upper molar possessed as many as thirty plates and the third lower molar twenty-six.

Second only in size to the imperial mammoth, the Jeffersonian mammoth succeeded its imperial forerunner and survived the severe climate of the Fourth Glaciation, at the close of which it became extinct.

THE WOOLLY MAMMOTH (RACE XV).—Late in the Age of Man arrived the woolly mammoth (p. 21), closely related to the *Elephas primigenius* of the ancient steppes and tundras of western Europe. The first to make very close comparison between the west European and the American varieties of this boreal race was Dr. Hugh Falconer, who declared that while the same number of enamel ridge plates was present in the forms of both regions, namely, twenty-four in the last molar of each jaw, the American animals were in general characterized by still finer and more compressed ridge plates than those of western Europe. Thus we may distinguish one of our own forms as *Mammonteus primigenius americanus*, while in Indiana and in Alaska we find a type of mammoth with close-fitting enamel ridge plates to the number of twenty-seven and of such exceeding fineness that we have named it *Mammonteus primigenius compressus*. This adaptation of the grinding teeth for grazing habits was to enable the animal to feed upon the hard grasses which covered the tundras and steppes of the north during the summer season. Thus the woolly mammoth was chiefly a grazer, as proved by the stomach contents of frozen carcasses recovered from the ice in Siberia.

TABLE OF COMPARATIVE HEIGHTS OF CERTAIN ELEPHANTS AND MASTODONTS

Common Name	Scientific Name	Height
Imperial Mammoth	*Archidiskodon imperator*	13 feet 6 inches
African Elephant	*Loxodonta africana*	11 feet 4 inches
Jeffersonian Mammoth	*Parelephas jeffersonii*	10 feet 6 inches
Indian Elephant	*Elephas indicus*	10 feet
American Mastodon	*Mastodon americanus*	9 feet 6 inches
Woolly Mammoth	*Mammonteus primigenius*	9 feet 3 inches
Giant Longirostrine	*Trilophodon giganteus*	7 feet 9 inches
Small Mediterranean Elephant	*Loxodonta (Pilgrimia) mnaidræ*	7 feet
Texas Serridentine	*Serridentinus productus*	5 feet 8 inches
Small Elephant of Malta	*Loxodonta (Pilgrimia) meltiensis*	5 feet
Fayûm Longirostrine	*Phiomia osborni*	4 feet 5 inches
Young Congo Elephant	*Loxondonta africana pumilio*	4 feet 5 inches
Smallest Elephant of Malta	*Loxodonta (Pilgrimia) falconeri*	3 feet
Fayûm Mœrithere	*Mœritherium andrewsi*	2 feet 1 inch

The woolly mammoth is relatively diminutive in size, not much exceeding nine feet and, despite the grazing adaptation in its grinding teeth, it shows its relationship both to the imperial and the Jeffersonian mammoths in two outstanding characters, namely, the extreme acuteness of the apex of the skull and the strong incurvature of the tusks, which completely cross each other in old age and no longer serve either for purposes of combat or for the gathering of food. Remains of the woolly mammoth are relatively rare in the United States but a few fine skulls have been recovered from Indiana and from Alaska, in which the acute apex, the concave forhead, the extreme flattening and deepening of the cranium and the tooth sockets may be observed.

We know little of the external appearance of the imperial mammoth; it was probably nearly hairless like the Indian and the African elephants. The Jeffersonian mammoth, we believe, was partly hairy, for it is characteristic of the north temperate region both of Europe and the United States. The northern mammoth of the Ice Age was both hairy and woolly and was perfectly adapted to the extremely severe climate of the Arctic Circle and of the borders of the advancing ice sheets. Both in their immense geographic range and in their extremes of adaptation to different climatic zones, these three branches of the mammoth family rank as the *facile princeps* among the mammals which ruled the Northern Hemisphere during the Age of Man.

Stegomastodon arriving in Arizona. After restoration by Osborn and Knight

Mastodons of the Hudson Highlands

By HENRY FAIRFIELD OSBORN
President of The American Museum of Natural History

One of the greatest treasures of the American Museum is the unrivaled skeleton of the fossil proboscidean known as the Warren Mastodon. The present article gives the fullest and most authentic history of this specimen which has ever been published, thanks to the testimony of several eyewitnesses who have kindly written to the author, and to others.

The Warren Mastodon, found in 1845, was the fifth in a series of discoveries of mastodon skeletons, beginning with Peale's first skeleton of 1799, which like the Warren Mastodon was found in Orange County, New York. The first reference to mastodons along the Hudson was, however, as early as 1705.

The following table relative to early discoveries of the mastodon has been compiled from *The Mastodon Giganteus of North America*, which Dr. John Collins Warren published in 1852:

1705.—First mention of finding mastodon remains near Albany.

1714.—First published account of two teeth and a thigh bone found at Claverack, on the Hudson, thirty miles south of Albany.

1799–1801.—Peale's first skeleton, found on John Masten's farm, Orange County, New York. See Warren, Plate I, upper left-hand figure. Exhibited in London; in Peale's Museum, Philadelphia; and then disappeared.

1802.—Peale's second skeleton, "Baltimore Skeleton," purchased by Doctor Warren in 1848, dismantled. A very large jaw, described by Doctor Warren. See Warren, Plate I, upper right-hand figure.

1840–43.—Koch's "Missourium," a composite of several specimens found near Kimmswick, Missouri. Remounted by Richard Owen, in the British Museum. See Warren, Plate I, lower right-hand figure.

1844–45.—"Cambridge mastodon," found near Hackettstown, Warren County, New Jersey, twenty miles from Newark. See Warren, Plate I, lower left-hand figure.

1844.—"Shawangunk Skull," found near Scotchtown, Orange County, New York; now in the American Museum, Warren Collection.

1845.—The Warren Mastodon in the American Museum, found on the Brewster Farm, Orange County, New York. See Warren Memoir, Vignette; also Plate I, center figure; also Plates IV to XXV.

In *An Outline History of Orange Co.*, by Samuel W. Eager, published in 1846–47, only a year after the discovery of the Warren Mastodon, is found the following quaint narrative of the succession of discoveries in Orange County, and an interesting reflection of the scientific opinions of the middle of the nineteenth century.

"We cannot, without disrespect to the memory of a lost but giant race, and slighting the widespread reputation of old Orange as the mother of the most perfect and magnificent specimens of terrestrial animals, omit to tell of the mastodon. Contemplating his remains as exhumed from their resting place for unknown ages, we instinctively think of his great and lordly mastery over the beasts—of his majestic tread as he strode these valleys and hill-tops—of his anger when excited to fury—stamping the earth till trembling beneath his feet—snuffing the wind with disdain, and uttering his wrath in tones of

EXCAVATION OF THE PEALE MASTODON

In 1799 there was discovered on the farm of John Masten, near Newburg, New York, the skeleton known as Peale's first mastodon. The exhumation of this skeleton, portrayed in the painting, was carried on in the year 1801. The principal figure in the foreground is Dr. Charles Willson Peale. The other two figures assisting him in holding the scroll are probably Titian and Rembrandt Peale.

This photograph shows at work twenty-one men and two boys of the twenty-six who were engaged under the direction of Doctor Peale. The elaborate machinery that occupies the center of the picture consists of a continuous bucket chain with a long trough. It was designed by an ingenious millwright to keep the excavation free of water. A number of the male onlookers and even some of the workmen wear tall beaver hats as part of the quaint dress of the period. The whole scene, painted after the manner of other scientific portraits of the day, is a delightful reminiscence of the country life along the Hudson one hundred twenty years ago.

(After photograph of the painting by Rembrandt Peale, belonging to Mrs. Bertha White, now deposited in the American Museum of Natural History.)

thunder,—and the mind quails beneath the oppressive grandeur of the thought, and we feel as if driven along by the violence of a tornado. When the pressure of contemplation has subsided and we recover from the blast, we move along and ponder on the time when the mastodon lived,—when and how he died, and the nature of the catastrophe that extinguished the race; and the mind again becomes bewildered and lost in the uncertainty of the cause. Speculation is at fault, and our thoughts wander about among the possible accidents and physical agents which might have worked the sudden or lingering death of this line of terrestrial monarchs.

"Upon these subjects, wrapt in the deep mystery of many ages, we have no fixed or well-considered theory; and if we had, the limits of our paper would forbid us to argue it up before our readers, and argue down all hostile ones. But we may briefly enquire, whether the cause of the death and utter annihilation of the race, was one great overwhelming flood which submerged the earth and swept down these animals as they peacefully and unsuspiciously wandered over the plains and hills around us. Or was it some earthquake convulsion, full of sudden wrath, which tore up its strong foundations and buried this race among the uplifted and subsiding mass of ruins; or was it some unusual storm, black with fury and terrible as the tornado, which swept the wide borders of these grounds, and carried tree and rock and living mastodon in one unbroken stream to a common grave, or was it the common fate of nations, men and every race of created animals of water, land or air, which overtook and laid the giants low? that by the physical law of their nature, the decree of heaven, the race started into being—grew up to physical perfection—and having fulfilled the purpose assigned by their creation, by a decrease slow, but sure as their increase, degenerated in number, and gradually died away and became extinct. Or was it some malignant distemper, fatal as the Egyptian murrain, which attacked the herd in every locality of this wide domain—sending its burning poison to their very vitals—forcing them to allay an insatiate thirst and seek relief in the water ponds around them, and there drank, and drank, and died? Or was it rather, as is the general belief in this community, that individual accident, numerous as the race, befell each one, and in the throes of extrication sank deep and deeper still in the soft and miry beds whefe we now find their bones reposing?

"We have thus briefly laid before our readers all the causes which we have heard assigned for this remarkable, ancient, and wide-spread catastrophe, and leave them to the speculation of others, while we wait for time and the developments of geology to uncover the cause.

"But when did these animals live and when did they perish, are questions equally wrapt in profound mystery, and can be answered only when the true cause of their death is found. In the meantime we ask, were they pre-Adamites, and did they graze upon the fields of Orange and bask in the sunlight of that early period of the globe?—or were they antediluvian, and carried to a common grave by the deluge of the Scriptures?—or were they postdiluvian only, and till very recent periods wandered over our hills and fed in these valleys; and that now some wandering lord of the race, an exile from the land of his birth on the banks of the great father of waters, is gone in silence and melancholy grandeur to lay himself down and die in the yet unexplored regions of the continent? On the points of vital interest in solving the great question of time and mode of death, we hazard no conjecture. Among geologists the opinion is fast gaining ground, that the epoch of the appearance of the mastodon on earth was about the middle of the tertiary period,—and that he was here ages before man was created,—that before that epoch warm-blooded terrestrial animals had not appeared. The period of their extinction is thought to be more doubtful, but probably was just before the creation of the human race.—Geologists think there is no evidence sufficient to establish the fact that man

and the mastodon were contemporary. —Time and further investigation may explain the mystery.[1]

WHEN FIRST FOUND

"The remains of the mastodon were first found in this State, near Albany, probably as early as 1705, as appears from the letter of Gov. Dudley to the Rev. Cotton Mather, of July 10, 1706—a copy of which is furnished and worth reading.[2] The accounts which state it to have been in 1712 are erroneous—taking, probably the date of Cotton Mather's letter (of that date) upon this subject to Dr. Woodward, as the date of the finding. They were next found by Longueil, a French officer, on the Ohio River, in 1739. In 1740 large quantities were found at Big Bone Lick, in Kentucky, carried to France and there called the "Animal of the Ohio." Since which many have been found in various parts of the Union.

"No locality,[3] except the Big Bone Lick, has contained a greater number of these remains than Orange County. The first were discovered in 1782, about three miles south of the village of Montgomery, on the farm now owned by Mr. Foster Smith. These bones were visited by Gen. Washington and other officers of the army while encamped at Newburgh in 1782–3. The Rev. Robert Annan, who then owned the farm, made a publication at the time, describing the bones, locality, etc., which caused Mr. Peale subsequently to visit this county.

"In 1794 they were found about five miles west of the village of Montgomery, just east of the residence of Archibald Crawford, Esq., and near the line of the Cochecton turnpike. In 1800 they were found about seven miles northeast from Montgomery, on or near the farm of Dr. George Graham. In 1803, found one mile east of Montgomery, on the farm now owned by Dr. Charles Fowler. These were the bones dug out by Mr. Peale of Philadelphia, in 1805 or 6,—and the writer, then a boy at school in the village, saw the work in progress from day to day. In 1838 a tooth was found by Mr. Daniel Embler, of Newburgh, on or near the farm of Samuel Dixon, Esq., of that town. In 1844, found eight miles southwest from Montgomery, on the farm of Mr. Conner, near Scotchtown, in Wallkill. In 1845, found about seven miles east of Montgomery, on the farm of Nathaniel Brewster, Esq.; and, in the same year, on the farm of Jesse C. Cleve, Esq., in Hamptonburgh, about twelve miles southeast of Montgomery. They were also found in the town of Goshen some years since, but the time and locality we do not know. There have been at least a dozen findings of these bones in the County. From these enumerations it would appear as if the village of Montgomery was the center of the circle of these various findings

. . . . .

"The animal [the skeleton found on the farm of Nathaniel Brewster and subsequently known as the Warren Mastodon] was supposed to be of great age—judging from the length and size of the tusks, and from the fact that some bones, which in young animals are separate, in this had grown firmly together.

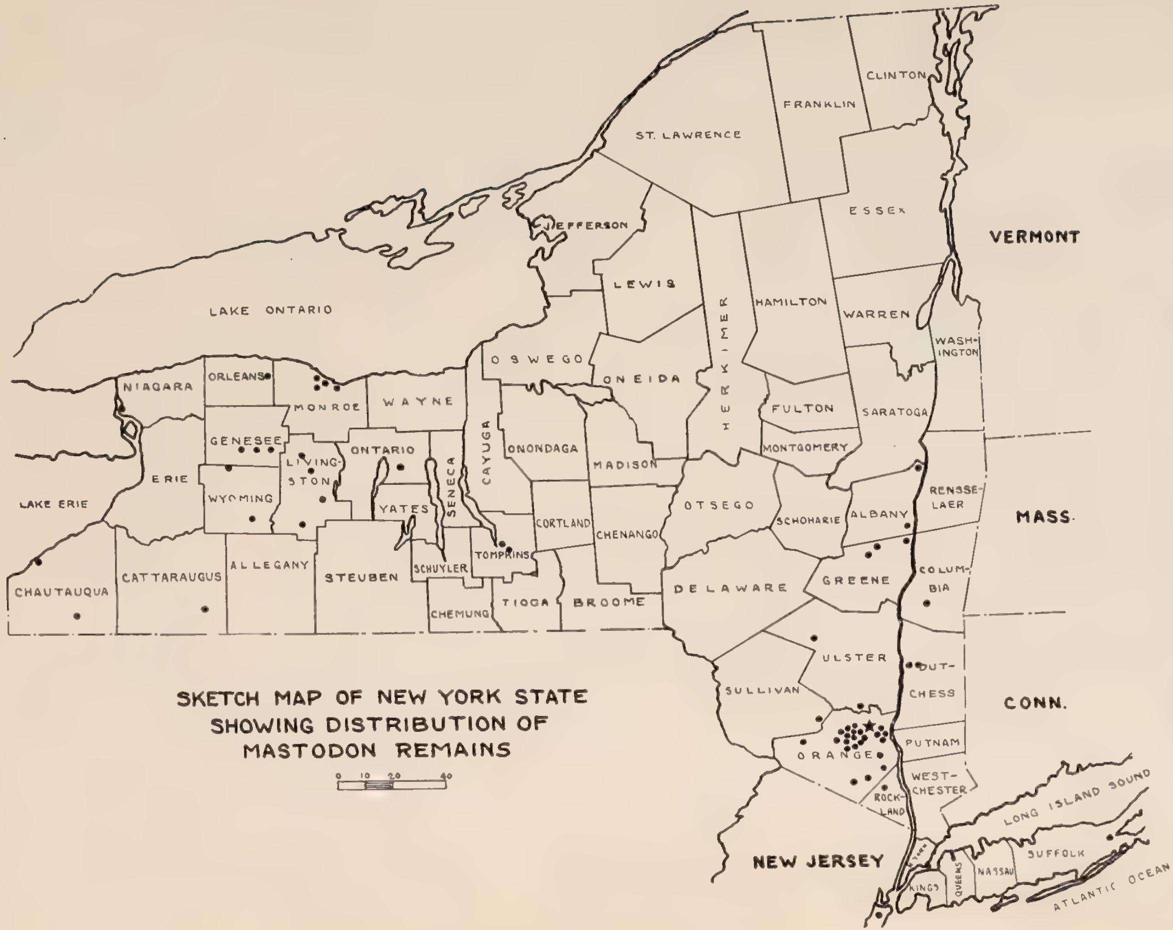
POSITION OF THE BONES WHEN FOUND

"Having measured the giant, let us inspect the place where found, uncover his resting place and observe his position in death. Mr. Brewster was digging out marl, and his workmen came upon the skeleton, every bone of which they succeeded in exhuming. Though wanting some of the toes of the forefoot, we believe they were found and carried away in the pockets of some of the early visitors. Like all others in this County, these were found in a peat formation, but of very limited extent, between two slate ridges. They were six feet beneath the surface—yet so deep was the peat below that its bottom could not be reached with an iron rod of several feet in length. The animal was thus held in suspension, and as the spot was wet and spongy, never dry perhaps from the

[1]The reader is referred to an article entitled "Did the Indian Know the Mastodon?" by Jay L. B. Taylor, NATURAL HISTORY, 1921, pp. 591–97; also to the article by William B. Scott "On American Elephant Myths," *Scribner's Magazine*, 1887, p. 469.

[2]This letter is not reproduced in the present article.

[3]Remains indicating 300 animals were found at Kimmswick, Missouri.



SKETCH MAP OF NEW YORK STATE
SHOWING DISTRIBUTION OF
MASTODON REMAINS

DISCOVERY SITES OF MASTODONS IN NEW YORK

This map, taken from that which appears in the article entitled "Mastodons of New York," by Dr. John M. Clarke (New York State Museum, *Bulletin 69*, published 1903) shows, by the concentration of the dots just north of the Hudson River Highlands in Orange County, how numerous are the mastodon remains in that area. The site where the Warren Mastodon was discovered—formerly known as the Nathaniel Brewster Farm but now called the Sycamore Farm—is indicated on the map by a star

The Warren Mastodon was discovered on the site marked by the star, in the valley south of Orange Lake and about two hundred yards north of the Cochecton Highway at East Coldenham. The skeleton was at first known as the Brewster Mastodon because of the fact that the farm on which the find was made was the property of one Nathaniel Brewster, a grandson and namesake of whom is now the owner of the land. Reproduced from the Newburg Quadrangle Topographical Survey, State of New York, United States Geological Survey, edition of September, 1903, reprinted September, 1910

time he entered, it caused their perfect preservation.

"Beginning at the bottom, the following were deposits which from time to time filled up the pond:

1, Mud, more than ten feet,
2, Shell Marl, three feet,
3, Red Moss, one foot,
4, Peat, two feet.

The bones laid below No. 3 and occupied nearly the position the animal did when alive, and the whole position that of one mired. If there ever was one that came to his death in that way, this is the one.

. . . . . .

"In Godman's Natural History, article Mastodon, is recorded an instance of the same kind [the preservation of stomach contents], and puts the fact beyond all question, that the contents of the stomach of the Brewster [Warren] mastodon were found. The animal was dug up in Wythe Co., Va., and the stomach found,—the contents carefully examined, and found to be in good preservation. They consisted of reeds half masticated—of twigs of trees, and of grass or leaves.

We have made free use of the article written by Dr. A. J. Prime, of Newburg, and found in the American Quarterly Journal of October, 1845, and various newspaper publications made by the same gentleman."

Thus ends our quotation of the quaint narrative of Samuel W. Eager.

OTHER REMINISCENCES OF THE DISCOVERY

The American Museum is indebted to Mrs. George F. Elliott of Westfield, New Jersey, for the following reminiscence of the discovery, contained in a letter of March 21, 1906, addressed to the late J. Pierpont Morgan, the donor of the Warren collection to the American Museum Mrs. Elliott, writes:

"I was much interested on reading in this morning's *Tribune* of your recent purchase of the American mastodon from the Warren heirs; interested firstly, because it will now be given to the public; secondly, because it was found on, or in, my grandfather's farm in East Coldenham, six miles west of Newburgh, on the Newburgh and Cochecton turnpike. As a child I distinctly remember the excitement that prevailed in the neighborhood at the find and during the time it was on exhibition in my grandfather's barn. It was wired and set up on the premises. Doctors Warren, Hitchcock, Blackman, and Prof. Silliman were all there at times. The location where it was found was in a depression or sort of basin of marl, which they were taking out for improving the land elsewhere. The head was struck first, for the animal was standing erect, as it had sunk in the soft marsh. Even the contents of the stomach were intact, consisting of twigs as large as a

I was present at
the original discovery
of the Warren Mastodon
discovered in 1845
and assisted in the
Exhibition of same

J. H. Cromwell
McBain
Sep 2nd 1907 Mich

THE WARREN MASTODON IN SITU

Vignette showing the Warren Mastodon as it was stretched out when originally discovered about six miles northwest of Newburg and about one mile south of Orange Lake. The vignette, which appeared originally in color on the title page of Doctor Warren's *Mastodon Giganteus of North America*, is designed to show the succession of strata under which were found the skeletal remains. Usually all these strata were covered during the wet season with a depth of water varying from one or two feet to six or eight feet, but during the unusually dry season of 1845, the year of the discovery of the skeleton, the area had almost dried up. According to Doctor Warren, the position of the extremities shows that the animal, at the time of its destruction, was making strong efforts to extricate itself from the abyss into which it had plunged. Beneath the body and limbs is a stratum of clay but the body was embedded in light-colored shell-marl, which incased the head, the right anterior limb, spinal column, part of the ribs, pelvis, and the tail. Above the shell-marl was a layer of red moss of a pinkish color; the top layer was of dark-colored peat a foot or two in thickness; above this in ordinary seasons was the depth of water already referred to

On Saturday, August 19, 1922, the writer visited the locality where the Warren Mastodon was discovered and had the good fortune to meet Mr. Nathaniel Brewster, the grandson of the original owner and excavator of the skeleton, who with his daughter, Miss Brewster, gave the writer a most courteous reception.

Mr. Brewster pointed out the original boxes, excellently constructed, in which the skeleton was originally packed and transported from place to place for exhibition. Although a small boy at the time, being only three years of age, he distinctly recalls placing his little fist in the eye socket of the mastodon skeleton. He also recalls the spot where the mastodon was found, now buried beneath a pond of considerable size. On September 6, 1922, Mr. S. H. Chubb visited the site with his excellent camera and photographed Mr. Brewster pointing to the spot in question (see lower picture; the upper picture shows another view of the same locality). The relation of the site to its envoirnment is shown in the map on p. 8.

man's finger, and were gathered in a bushel basket. The tusks were also perfect when found, but crumbled on coming in contact with the air. There is a brooch in the family with the head in 'profile' of one of my uncles carved on it, made from a piece of the outside of these tusks; there is also a part of a tooth that broke off after it was set up. My oldest brother, who now occupies the homestead, has much interesting data in connection with it, also an engraving of the different strata of soil in which it was found, with a cut of each separate bone, and would furnish you, no doubt, with anything of interest to you in connection with it. It was sold to Doctor Warren by my father while he had it on exhibition either in Hartford of in New Haven."

Another reminiscence is that contained in a letter received at the American Museum on August 16, 1907, from Mr. W. M. Nelson of Equinunk, Wayne County, Pennsylvania, who writes:

"So far as I know, I am the only living man today[1] who saw the skeleton of the animal taken from the marl pit on the farm of Nathaniel Brewster, six miles west of now Newburgh City, where the road runs north to Orange Lake. I saw the entire skeleton taken out and bones wired together by Doctor Prime, of Newburgh, in Mr. Brewster's barn. This was done in sections so it could be set up and taken down and shipped in the boxes as freight. It was on exhibition about the country by Wm. Brewster and Clinton Weeks, son and son-in-law of Mr. Brewster.

"Squire Eager's history of Orange Co., New York, gives the dimensions of the skeleton as follows: length of skeleton 33 feet; skull between eyes 2 feet, 1 inch; length of skull 3 feet, 10 inches; number of bones 220; ribs, 20 on each side. Total weight of bones, 1995 pounds. . . . The mastodon's backbone was found about 5 feet below the surface in the marl pit. Every bone was found and wired, except one toe bone, about the size of an egg. I was a boy some 16 or 18 years old at the time and took it all in. I remember nothing about Professor Warren. Doctor Prime wired the bones together and I saw him most every day at the work of setting up the skeleton. I do not know whether this history is of any interest to you now, but it will hold water, so far as my memory is concerned."

The above reminiscences may be supplemented with the account of the discovery gathered from the memoir by Doctor Warren published in 1852:

"The summer of 1845 had been unusually dry; many small lacustrine deposits were exposed by the drought, and their contents removed to fertilize the neighboring fields. The spot above described, though usually covered by a small quantity of water, had been left dry (an occurrence never known before); and Mr. Brewster, wishing to avail himself of its contents, had employed a number of laborers to remove them. The men had dug through a thickness of two feet of peat-bog, a layer of red moss about a foot thick, and then fell upon a bed of shell marl (*vide* Vignette).[1] After raising about a foot of this, they struck on something hard; and a question arose whether it was a rock, a bone, or some other substance. Night approaching, it was necessary to intermit their labor until the following day.

"Mr. William C. Brewster, son of the proprietor, and Mr. Weeks, his son-in-law, with assistants, in the presence of a large number of persons, neighbors, and travellers, proceeded to examine the object of their curiosity. The stroke of a spade brought up a portion of bone, and everyone was then willing to believe they had discovered the last retreat of one of the ancient mastodon inhabitants. The labor of exhumation then proceeded rapidly; and the part struck was ascertained to have been the summit of the head. This, being uncovered, disclosed to the eyes of the spectators the full extent of the cranium, which was four feet in length.

[1]Another survivor is Mr. Nathaniel Brewster, a grandson of the owner of the farm at the time of the discovery, who is shown on p. 33 pointing to the spot from which the skeleton way recovered.

[1]The vignette is reproduced on p. 32 of the present article.

The lower jaw was distorted a little toward the left side. The bones of the spine, tail, pelvis, and ribs, were successively found, for the most part in their natural relation to each other. The anterior extremities were extended under and in front of the head, as if the animal had stretched out its arms in a forward direction to extricate itself from a morass, into which it had sunk. The posterior extremities were extended forward under the body. The tusks lay with their convexities outwards, their anterior extremities opposed to each other nearly meeting; and thus the two tusks, taken together, described a large part of a circle. (*Vide* Vignette.)

"At the end of the second day's labor, the whole of the skeleton had been obtained, with the exception of the posterior part of the sternum, a few bones of the feet, and a number of the caudal vertebræ, some of which were recovered afterwards. The bones were in an almost perfect state of preservation. They were not black, like most of the mastodon bones, but of a brown color, like those of a recent human skeleton, which had been in use a considerable time. It is worthy of remark, that no mastodon bones but those belonging to this individual, and no other bones excepting two or three of animals recently entrapped in the mire, were found in this deposit."[1]

. . . . .

"Doctor Prime, who was present, describes its appearance as follows:—'In the midst of the ribs, embedded in the marl and unmixed with shells or carbonate of lime, was a mass of matter, composed principally of the twigs of trees broken into pieces of about two inches in length, and varying in size from very small twigs to half an inch in diameter. There was mixed with these a large quantity of finer vegetable substance, like finely divided leaves; the whole amounting to from four to six bushels. From the appearance of this, and its situation, it was supposed to be the contents of the stomach; and this opinion was confirmed on removing the pelvis, underneath which, in the direction of the last of the intestines, was a train of the same material, about three feet in length or four inches in diameter.'"[1]

[1]*The Mastodon Giganteus of North America*, by Dr. John C. Warren, pp. 5 and 6.

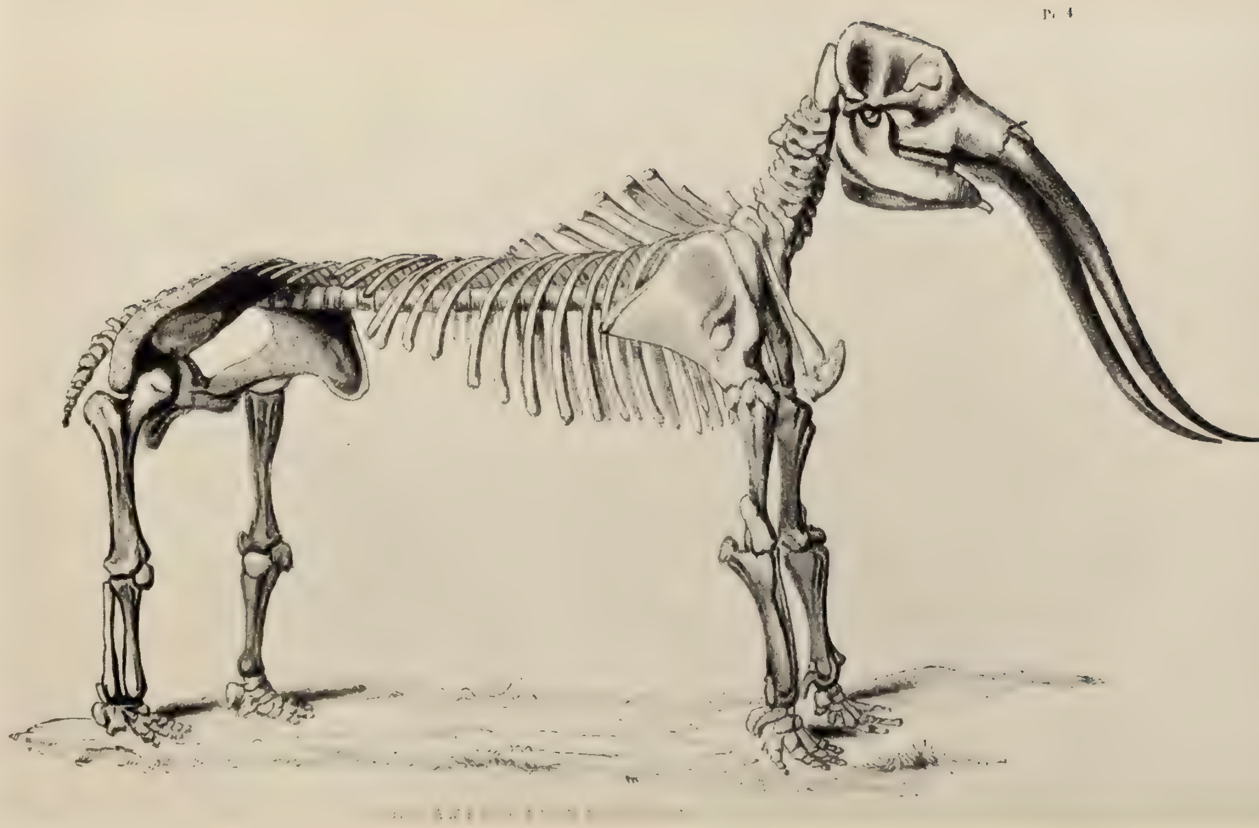
TOUR OF EXHIBITION

Owing to the fact that the bones were buried in a pure shell-marl layer, they were, when found, in a perfect state of preservation; of light brown tint, not of the dark brown or nearly black tint of the mastodon skeletons exhumed from swamp muck, which are discolored by decaying vegetable matter. As narrated by two eyewitnesses, the skeleton was wired together and set up in such form that it could be exhibited for three or four months during the years 1845 and 1846, in the city of New York and in several New York and New England towns. Luckily, it does not appear that any of the parts were lost during this period of exhibition and travel.

The excellently made boxes in which the skeleton of the Warren Mastodon was transported from point to point for exhibition still remain in the possession of Mr. Nathaniel Brewster, The impression which the mastodon made on observers in the city of New York is shown by an extract from the journal of one of the pupils of the New York Institute for the Deaf and Dumb, October 16, 1845:

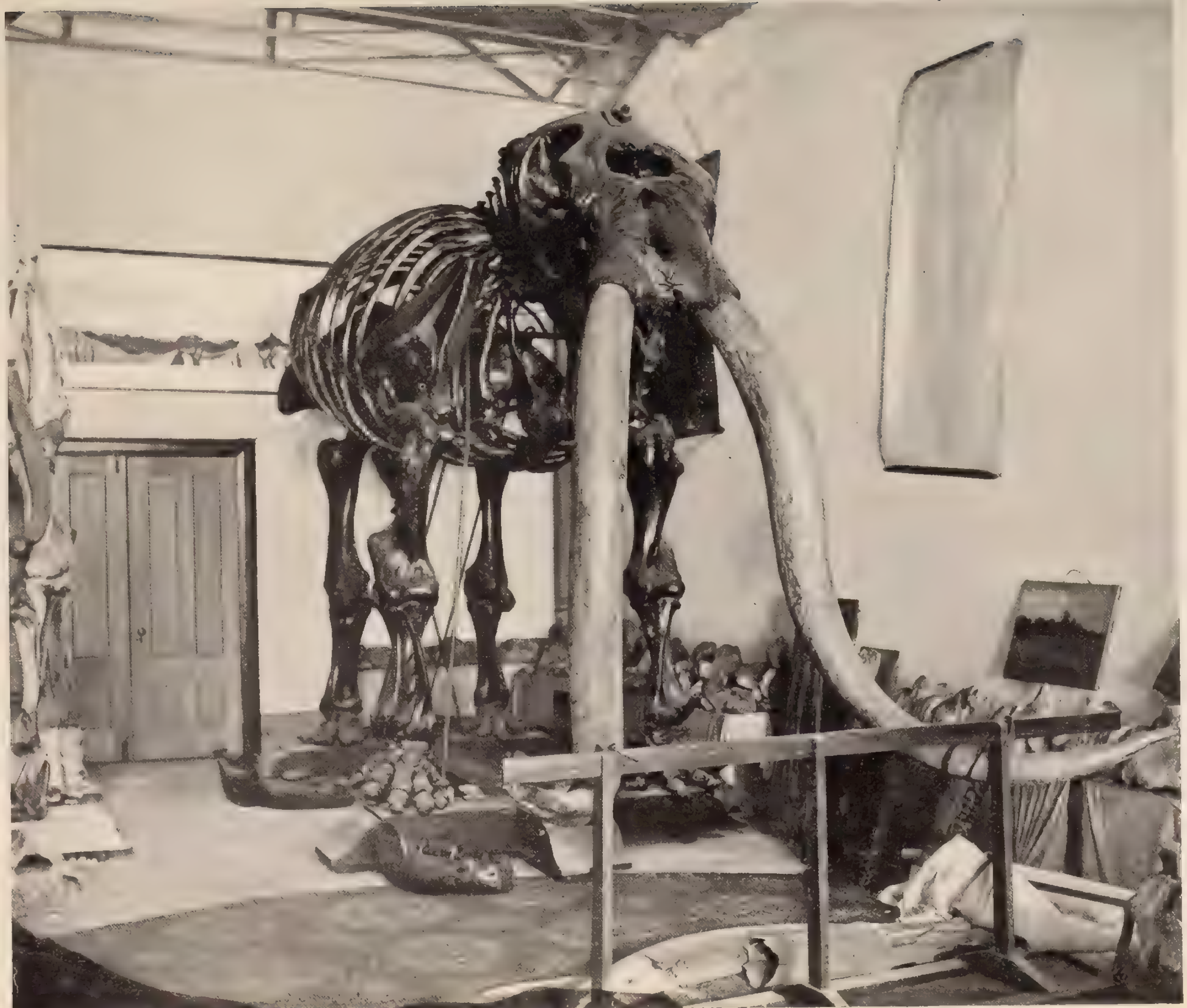
"Having been kindly invited by the proprietors of this wonderful exhibition, we went up into the Minerva Rooms, 406 Broadway, and looked at the American Mastodon, one of the greatest curiosities in the world, according to my imagination. We steadily gazed at it with much astonishment. The bones of it are articulated together or fastened to each other by iron nails so as to form a skeleton, and it is now exhibited in this city. Two long artificial tusks measuring ten and a half feet in length are fixed into the

[1]*Idem.*, p. 144.



THE WARREN MASTODON AS IT WAS MOUNTED SHORTLY AFTER ITS DISCOVERY

The figure is reproduced from the *American Journal of Agriculture and Science*, Volume II, Number 2, conducted by E. Emmons, Albany, and A. J. Prime, Newburg. In their article, "The Great American Mastodon," Messrs. Emmons and Prime remark: "The skeleton has since been arranged and set up, and this has been done with great care and the strictest attention to the articulating surfaces of all the bones, which we believe has not been the case with others which have been put together"



THE WARREN MASTODON AS REMOUNTED IN 1849

For fifty-seven years, that is from 1849–1906, the Warren Mastodon, remounted as shown in the picture, was exhibited in the Warren Museum in Boston. In 1906 it was acquired, thanks to the generosity of the late J. Pierpont Morgan, by the American Museum.

The skeleton, as here depicted, is covered with heavy black varnish. The imitation tusks are made of papier-maché and were so lengthened as to sweep the ground and curve outwards at the extremities. The chest and backbone were raised two feet above the top of the shoulder blade, or scapula, and as a result the natural height of the animal was increased from nine feet to twelve feet. Beneath the Warren Mastodon are tusks and grinding teeth of other specimens. Around the base of the walls are many vertebræ of the giant *Zeuglodon*, the archaic fossil whale of southern United States.

As photographed in the interior of the Warren Museum, 92 Chestnut Street, Boston

skull; the old tusks of nature are almost corrupted, and it is said that they were found entire in the skull when first discovered, but they have fallen in pieces so that they cannot be made fast. The large vertebræ of its spine or backbone gradually increase in size from the extremity of the tail to the head. We could stand below the long ribs. We examined the legs and bony toes with great curiosity. The whole bones weigh 2002 pounds but they must have weighed 20,000 pounds when it was living. The skeleton measures 29 feet in length, and the height of its head, 12 feet, that of its back, 10 feet, and the width of the pelvis, 6 feet.

"The skeleton, which has been brought to this city for a show, was found in a marl bed on a farm at New burgh, of New York. I am very proud of that skeleton first discovered in this state.

"It is supposed that this animal on walking along the marl bed, sunk into it by its legs adhering closely to the marl and it was drowned. It remained in it for a long time. Previous to the discovery, nobody knew the place where it was buried. We should be thankful to the proprietors who found it and took great pains to fix the bones firmly into a skeleton. What a wonderful success!! It leads us to admire the power and wisdom of our Almighty Maker who made the largest of animals."

DOCTOR WARREN ACQUIRES THE MASTODON

Fortunate was its purchase in 1846 by Dr. John Collins Warren, professor of anatomy in the Harvard Medical School, who paid $5000 for it. Doctor Warren, who about this time became president of the Boston Society of Natural History, had the skeleton transferred to Boston, where it was mounted under his direction by Dr. N. B. Shurtleff; this was its second mounting. It was exhibited to Sir Charles Lyell, the distinguished English geologist, who made a tour of the United States during the years 1841–45; also to Professor Jeffries Wyman, founder of the Museum of Comparative Anatomy, Harvard Medical School; also to Professor Louis Agassiz, who was called to Harvard University in the year 1848.

The teeth of the mastodon had been known in America since 1705 and in Europe ever since Longueil, a French officer, brought them back from the banks of the Ohio River in 1739; they had been examined and described by the great French naturalist of the period, Buffon; they had been assigned the specific name of *Elephas americanus* by the American naturalist, Kerr, in1 792; they had been falsely confused with those of the woolly mammoth of Siberia by Blumenbach, who gave this animal the name of *Mammut;* they had finally, in 1806, been properly christened 'mastodonte' by the great French naturalist, Cuvier; yet the actual structure and proportions of the mastodon still remained unknown. Consequently the discovery and mounting of the Warren Mastodon skeleton was a really great event in the science of palæontology; it rendered possible for the first time a knowledge of the complete animal. It appears, however, that Doctor Warren was not satisfied with the mounting by Doctor Shurtleff, nor with the security of the building where the skeleton was first exhibited in Boston, because in 1849 the mastodon was remounted by Mr. Ogden under Doctor Warren's direction and placed with other collections in the especially erected fireproof building at 92 Chestnut Street, Boston, which soon became famous as the Warren Museum. It was at this time that the skeleton received its coat of black varnish, was raised two feet above its natural height, and was provided with the enormous pair of papier-maché tusks.

From 1849 to 1906 the skeleton remained in the Warren Museum in the

condition shown in our photograph on page 15. Professor Warren became intensely interested in adding to his museum other specimens of the mastodon, especially those discovered along the west bank of the Hudson River, and also in securing specimens from England, France, and Germany, for purposes of comparison. Thus his collection was enriched by the acquisition of the superb head of an old bull mastodon found near the Shawangunk Mountains, and hence known as the Shawangunk head; this is one of the largest, if not the largest, bull mastodon head ever found. Through active correspondence with Professor Jean Jacques Kaup, Doctor Warren secured casts of all the specimens that Professor Kaup had discovered near Eppelsheim not far from Worms in Germany, namely, *Mastodon longirostris* (signifying long-jawed mastodon) and *Dinotherium giganteum* (signifying the terrifying giant beast), animals which at the time aroused the wonder of Europe. Thus there were soon gathered in the Warren Museum numerous specimens from different parts of the world—North America, Europe, and Asia—bearing on the history of the proboscidean order. Doctor Warren devoted his spare time for six years to the study of these animals, and in 1852 issued a splendid monograph entitled *The Mastodon Giganteus of North America.* In April, 1908, the autograph copy of this precious publication, with marginal annotations in Doctor Warren's handwriting, was presented to the Osborn Library of the American Museum, together with *The Life of John Collins Warren, M.D.*, in two volumes, by Dr. Edward Warren.

REMOVAL TO THE AMERICAN MUSEUM

The writer of the present article had for years longed to secure this famous specimen for the American Museum but never dreamed that it would be possible to obtain it. It appeared that the entire Warren collection was entailed in the will of Doctor Warren and that the heirs were not at liberty to dispose of it until the decease of the last of the immediate descendants. The writer was greatly surprised, therefore, when he received a letter from Dr. Thomas Dwight of the faculty of the Harvard Medical School, indicating that the entail was at last closed and that the collection might be offered for sale under certain conditions. This letter came on a Friday afternoon and the writer left the same evening for Boston, arriving in Doctor Dwight's study on Saturday morning; he accompanied this distinguished anatomist to the old Warren Museum on Chestnut Street to view the famous skeleton for the first time. The black varnish appeared to present an obstacle, but some vigorous scratching with a penknife revealed the rich light-brown color of the bone beneath. A friendly interchange of opinions with Doctor Dwight ensued; a valuation was agreed upon for the entire collection, but there was still little thought in the writer's mind that it could be secured by the American Museum. On the Monday following, the prince of museum benefactors, Mr. J. Pierpont Morgan, authorized by telephone an offer of $30,000. This offer was immediately accepted and a few days later Dr. William Diller Matthew went to Boston to pack up the entire Warren collection, covered as it was with a half century of Boston dust. The collection was carefully inventoried, and with it came several valuable photographs and pictures, which are reproduced in the present article.

THE FOURTH MOUNTING OF THE WARREN MASTODON

In removal all the original framework was left in Boston, only the bones being packed; in this separated condition the precious skeleton, covered with its thick coat of black varnish, reached New York, its native State, in safety. The first question which arose in our minds was whether it would be possible to remove the black varnish: this was answered through a series of experiments which resulted in the construction of special vats large enough to contain the longest and broadest bones, such as the thigh bones, the hip girdle, and the skull. Many weeks of immersion in pure benzine were necessary before the black varnish began to dissolve. This treatment was followed by vigorous scrubbing with pure spirits of alcohol, and one by one the bones emerged from this prolonged and very expensive bath in all the purity and beauty of color that characterized the skeleton when it was exhumed by Doctor Prime in 1845.

There still remained the problem of the tusks, which are invariably the most vital part of buried skeletons of the great proboscideans of the past. It appears that the original tusks could not be preserved entire by the methods then known. The discoverers were unable to prevent them from splitting, warping, and falling to pieces, especially at the butt. In order to preserve what could be saved intact, the butts of the tusks, already hopelessly split and warped, were sawed off under Doctor Warren's direction, and only the tips, about three feet in length, were treated and preserved. The butts, fallen into fragments, but still lying undisturbed in two of the original boxes used for transporting the skeleton, were found in the Warren Museum when the skeleton was repacked to be sent to the American Museum. The tips, treated with preservatives, were still intact in another box; but neither had been used apparently for measurements in making the papier-maché restorations fitted to the skull in the Warren Museum. This documentary evidence certainly was not used by Professor Warren, because in his three restorations he unfortunately accepted the erroneous original reports that the tusks as found were more than eleven feet in length; they were so described and illustrated by him in the entirely impossible position shown in the photograph on p. 37.

When the Warren collection reached the American Museum, it was very carefully looked over in a search for remnants of the original tusks, and finally the fragmentary fossil ivory was found, but inasmuch as most of the original records had been lost and no use of these materials had been made by Doctor Warren, it remained to be proved that the fragmentary butts of the tusks really belonged with the skull. The piecing together of these butts required several months of most ingenious and patient work on the part of one of our preparators, Mr. Charles Christman. The ends of each tusk were perfectly preserved, but there was no connection between these tips and the reconstructed butts of either tusk. Fortunately, when the butts of the tusks were sawed off, a single splinter of bone broke off, and finally this splinter was found to fit exactly to a fragment of the butt. There was great rejoicing in the laboratory when the relationship of these two fragments was discovered, because it enabled us to determine positively the length of the tusks as 8 feet, 7 inches.

The rebuilding of the tusks, which required several months of most patient work, had two very important

results: in the first place, it enabled us to place them properly in the sockets of the skull and to prove for the first time the exact relations of the mastodon ivories; secondly, a very painstaking examination of these tusks led to an important and most interesting discovery, namely, that it was possible to determine very closely the age of the Warren Mastodon. The ivory exhibits a series of growth rings which, counted from tip to base, seems to prove that the Warren Mastodon was perhaps thirty years of age at the time it sank into the bed of marl near Newburg. The right tusk included at least twenty-eight of these segments. The growth rings are shortest near the tip of the tusk when the animal is young, and increase in length from the tip toward the middle of the tusk, but not in a regular ratio. These growth rings do not correspond exactly in the opposite tusk, but in both tusks they are longest in the middle region. Nine smaller rings are in the lower part. The writer's theory regarding these growth rings is that during the summer season, when all the conditions of life were favorable, and perhaps during the rutting period, when tusk growth was hastened by internal secretions from the reproductive glands, the growth of ivory was very rapid, the maximum growth in the 17–18 ring being 108 centimeters, of 4¼ inches, perhaps the maximum growth of a favorable season at the most vigorous reproductive period of life. The Warren Mastodon is an adult but not an aged specimen; the skeleton is apparently that of a younger animal than the one represented by the Shawangunk head. Some estimate the maximum age of the American mastodon at between thirty and forty years,—less than half the life span of the elephant, which attains more than one hundred years.

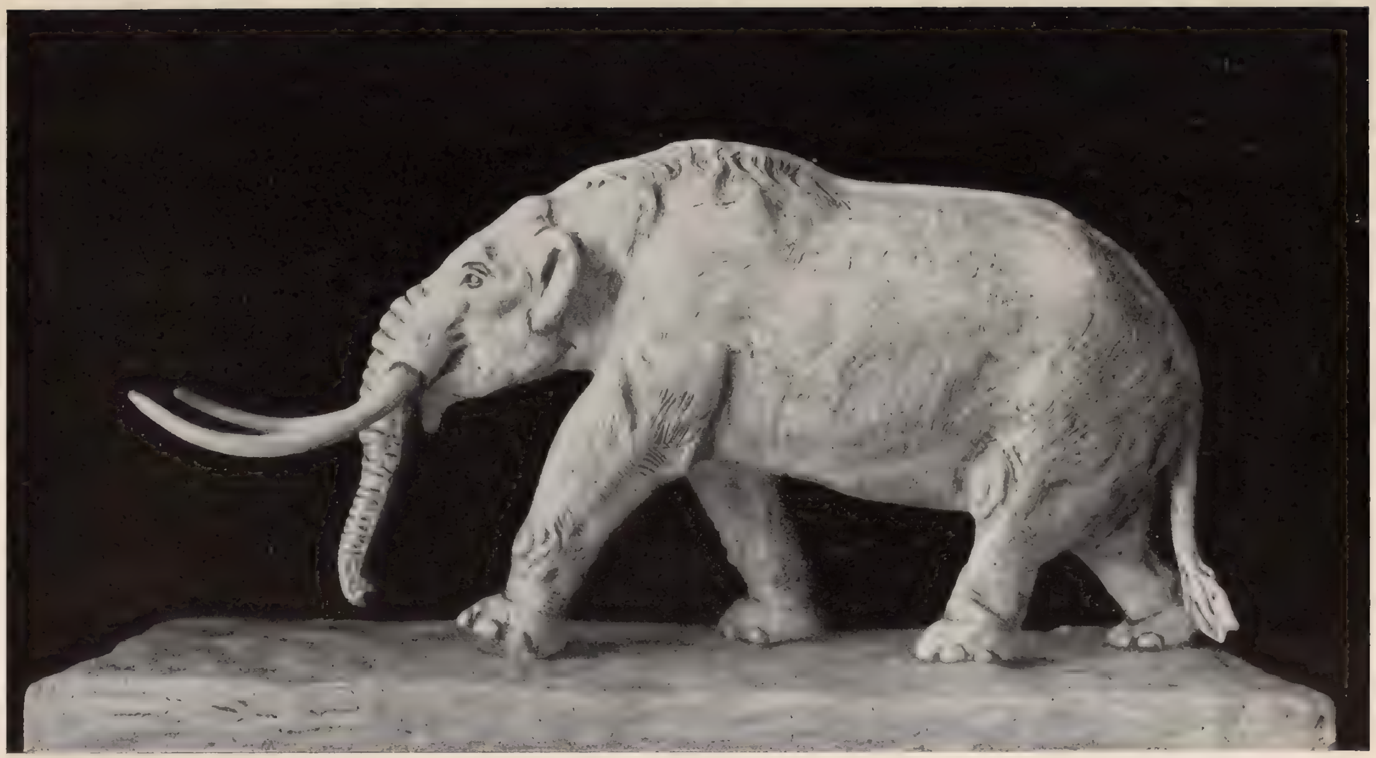
In repairing the tusks of the Warren Mastodon, it was found that the outer sheathing of the ivory (dentine) was in large part absent; the inner sheathing exposed a series of concentric constrictions and expansions which were observed to be approximately symmetrical on the two sides, as indicated by the two series of + signs in the lower figure. In the second place, it was noted that the intervals between these constrictions are broader in the middle stages of the growth of the tusk and narrower in the mature or later stages of its growth. On the hypothesis that these are actual annual increments of growth, the right tusk (A) consisted of about twenty-eight segments, which, allowing for the period of milk teeth and for the part worn off at the tip, would assign to the Warren Mastodon an age of perhaps thirty years

THE WARREN MASTODON AS REMOUNTED IN THE AMERICAN MUSEUM IN 1908

The skeleton is so complete that the only restorations or replacements which have been necessary are the following: caudal vertebræ 1–14, 16 28; all the terminal phalanges of the left forefoot except digit iii; and phalanx 2, digit iv, of the right forefoot. The following bones are introduced from other individuals: two posterior sternal bones, phalanx 2 on digits ii, iii, and v

MEASUREMENTS OF THE WARREN MASTODON

	Feet	Meters
Length, base of tusks to drop of tail	14 ft. 11 in.	4.55
Height to top of spines of back at the shoulders	9 ft. 2 in.	2.80
Tusks: Length of right tusk, on outside curve	8 ft. 6 in.	2.50
Length of tusk exposed	7 ft.	2.14
Thigh bones: Length of right	3 ft. 5 in.	1.05
Length of left	3 ft. 6½ in.	1.08
Pelvis or innominate bones: width	6 ft.	1.83



MODEL OF THE WARREN MASTODON BY CHARLES R. KNIGHT

This reconstruction made by Mr. Knight under the direction of Prof. Henry Fairfield Osborn, 1912–14, is one of a series of models of the extinct and living elephants, and of the mastodons, made to a uniform scale of $1\frac{1}{2}$ inches to the foot, or a $\frac{1}{8}$ scale. The heights of these animals in descending order are as follows:

Imperial mammoth, *Elephas imperator*,	13 feet, 6 inches
African elephant, *Loxodonta africana*,	11 feet, $8\frac{1}{2}$ inches, record of Rowland Ward
Indian elephant, *Elephas indicus*,	10 feet, 6 inches, record of Rowland Ward
Jeffersonian mammoth, *Elephas jeffersonii*,	10 feet, 6 inches, type specimen, American Museum
Woolly mammoth, *Elephas primigenius*,	9 feet, 6 inches, type specimen of western Europe
American mastodon, *Mastodon americanus*,	9 feet, 2 inches, as measured from the Warren Mastodon
Pigmy African elephant, *Loxodonta pumilio*,	6 feet, 2 inches, height of specimen in the New York Zoological Park

GROUP OF AMERICAN MASTODONS ALONG THE MISSOURI RIVER IN KANSAS

This restoration was made by Mr. Charles R. Knight, in 1920, under the direction of Prof. Henry Fairfield Osborn. There are two mastodon bulls, a cow, and a calf in the scene.

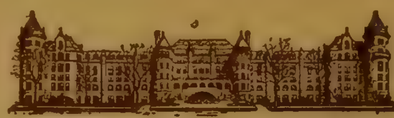
"THE COHOES MASTODON" AS HE APPEARED IN LIFE

This restoration is based on the most careful study of the muscular anatomy and proportions of the animal as derived from exact measurements of the skeleton, aided by comparison with the external form, skin texture, and other details in living elephants. The American mastodon had a coat of hair which somewhat resembled the hair of present-day elephants, though very much thicker and longer. The animal was thus adapted to the low temperature which prevailed in this region at the breaking-up of the Ice Age. It was a very distinctive member of the New York fauna of a few thousand years ago when mastodons may have roamed the swampy regions in herds comparable in number to those of the buffalo on the western plains fifty years ago. Parts of more than one hundred skeletons have been discovered in this state. This is the only life-size scientific restoration that has been made of the American mastodon.

Executed, under the direction of Dr. John M. Clarke, by Messrs. Noah T. Clarke and Charles P. Heidenrich for the State Museum at Albany in 1921–22

It was very important to make another correction in mounting this animal, namely, to ascertain its exact height at the shoulders. The temptation of preparators has always been to make both mastodons and elephants much larger than they actually were in life by raising the chest portion high above the tips of the shoulder blades. In order to determine this much-mooted question, our preparator at the time, Mr. Adam Hermann, spent a day on the back of Gunda, then the favorite riding elephant of the Zoological Park; placing his two thumbs on the tip of the spine and his two index fingers on the tip of the shoulder blades, he was able to note that the shoulder blades are on practically the same level as the summit of the spine. This observation enabled us to determine positively that the height of the backbone of the Warren Mastodon at the tip of the spine is 9 feet, 2 inches above the ground, whereas the length of the animal from the skull measured at the very base of the tusks to the droop of the tail is 14 feet, 11 inches, practically 15 feet. Thus the length of the animal's body is 6 feet, 9 inches greater than its height at the withers. Its proportions are thus totally different from those of any species of elephant. The long, low body is correspondingly broad, with an immense spread of six feet across the hips of pelvis. It is to emphasize the long, low, and broad proportions of the American mastodon, that the accompanying restorations were made by Charles R. Knight, under the writer's direction.

The reader who is interested to learn more about this subject is referred to works by Warren and others in the Osborn Library of the American Museum of Natural History, and especially to an article by Dr. John M. Clarke entitled "Mastodons of New York. A List of Discoveries of Their Remains, 1705–1902," in the Report of the State Paleontologist, 1902, New York State Museum. Bulletin, 69, p. 921.



THE AMERICAN MUSEUM OF NATURAL HISTORY

INDIAN COSTUMES
IN THE
UNITED STATES

By
CLARK WISSLER

GUIDE LEAFLET SERIES
No. 63

After Maximilian

Fig. 1. A Mandan Chief.

INDIAN COSTUMES IN THE UNITED STATES

A GUIDE TO THE STUDY OF THE COLLECTIONS
IN THE MUSEUM

By CLARK WISSLER

GUIDE LEAFLET, No. 63
NEW YORK, JULY, 1926

CONTENTS

INTRODUCTION

To get at a true understanding of native Indian costume one must look at the whole of the New World. To us, clothing means textiles, woven stuffs, but such materials were used in pre-Columbian days nowhere outside of the highlands of Mexico and South America, except in what is now New Mexico and Arizona, the area of true cloth.

Yet, there was one peculiarity to clothing made of these prehistoric textiles; the cloth was not cut and sewed by a tailor, but the garment was woven in about the shape in which it was to be worn. Naturally, this reduced all styles to straight lines and right angles. So we can say that all the textile costumes of the aborigines were non-tailored.

In other parts of the Americas the materials were chiefly the skins of animals. However, the users of skins fall into two classes, those who are tailors and those who are not. The Eskimo are true tailors, since skins are cut according to patterns and skilfully fitted to the body, so that in every respect their work compares favorably with that of our own tailors. The Canadian Indians, also, living next to the Eskimo, show almost equal skill, but as we move south through the forests of Canada, we note less and less skill in the tailor's art and in northern United States it vanishes, or becomes excessively crude. No Indian in what is now the United States made a sleeved garment like a coat, except a few of those along the Canadian border. Nor did such a thing as a skin coat appear in all of South America.

The picture we get, then, is that of a central group wearing cloth costumes, surrounded by a naked people who bundled themselves in skins when necessary, while in the extreme north were tribes who knew how to make well fitting coats and trousers of skins. So we see that if we wish to study the original costumes of Indians in the United States, we will, in the main, have to deal with a people who for the most part went naked and protected themselves from the cold by wrapping up in skin robes. "Naked savages," the colonists called them, and with much truth.

Now, while we have defined the basic character of Indian costume, we must prepare ourselves for a variety of styles, even tribal differences. As to what these differences were in prehistoric America cannot be completely stated. To say just what individualities in style prevailed in Manhattan Island, for example, when Hudson arrived here, is next to the impossible, but since, as we have seen, the more basic elements in a style tend to spread over a great stretch of country, we can be confident

that the general plan of costume say, for New York and New England, can be determined from the writings of explorers, supplemented by later studies among the Indians themselves. Yet, we must be continually on our guard, for the white traders sought to introduce their wares from the first and the missionaries set their faces resolutely against the exposure of any part of the body. And the Indian was always keen for a new style. Yet the effort in this brief study will be to state the styles prevailing when the first explorers arrived.

COSTUME MATERIALS

Little in the way of weaving was to be found in the aboriginal United States, except among the Pueblo dwellers of the Southwest, who raised some cotton. Yet, there is reason to believe that some cloth was made in the lands skirting the Gulf of Mexico, but these are the exceptions, skins of deer and other animals serving as the basic materials. All early writers are loud in their praise of the beautiful soft-tanned deerskins prepared by the Indians, a very fine costume material, indeed.

One of the most important aspects of costume is color, and, it is not strange that though skins were used throughout the area under consideration, these were made white, yellow, etc., as desired. In the account of De Soto's expedition, we read:—

> The skins are well dressed—the color being given to them that is wished—and in such perfection that when of vermilion they look like very fine red broadcloth; and when black—the sort in use for shoes—they are of the purest. The same hues are given to blankets.[1]

If we add feathers and soft barks of trees and grasses, the list of costume materials will be complete.

THE FORESTS AND THE PLAINS

Since most readers are familiar with the Indians east of the Rocky Mountains, we will give our chief attention to their costumes. This part of the United States presents two rather different environments, the plains and the forests, each of which has influenced dress and ornamentation. Nevertheless, the costume of these two areas is similar when compared with the remaining more specialized regions, as the Southwest, California, and Alaska. Perhaps one should say they are similar because made of skins, for all the Indians of the Plains and Forests were hunters, some exclusively so, and others, though varyingly engaged in agriculture, still chiefly dependent on the chase. Two halls in the Museum house the exhibits for the Indians of our eastern forests and of the western plains. Costumes are shown there, but none of these were made before 1492 and few, if any, more than a hundred years ago. Yet, many of them are prehistoric in style, or show no European influence.

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[1] *Narrative of the Career of Hernando de Soto* (Translated by Buckingham Smith, New York, 1866), 53.

One naturally thinks of an Indian as decked with feathers, and this was varyingly true of all tribes east of the Rocky Mountains, though most accentuated in the Plains. Yet nowhere was feather headgear the regular costume, but rather was it worn as regalia or insignia. Both sexes were innocent of hats or caps. It is a little surprising not to find these objects, for nothing seems more necessary to us in winter than a hat or a cap, yet it is not until we reach the Canadian border that such things come to notice. There in Colonial times we find a kind of cap, which the French called a "capot," but just what form this took in prehistoric times we do not know. So, in the Plains and Woodlands of the United States, the only protection to the head was that afforded by the robe which could be pulled up over the head, if desired.

Fig. 2. Seminole Hair Dress. The sides of the head are cropped close, leaving a ridge of hair on top and a similiar border to the face. After Macauley.

Now that heads were bare, we may expect some developments in hair dress and ornaments. The women rarely cut the hair, except in mourning; but we find a widespread tendency among the men to shave, or crop close, the hair from the sides of the head, leaving a ridge or roach in the middle, like a cockscomb. Judging from the earliest accounts such a tonsure prevailed among all tribes between Lake Champlain and Georgia and westward far out into the Plains. No doubt there were varieties in this style, but that surviving among the Seminole to recent times is the same as that in the drawings of John White, 1584.

One item should be noted, however, that the Indians about New York and in New England made an artificial roach of deer hair. Gookin says, "deer shuts made in the fashion of a cock's comb dyed red and crossing their heads like a half moon."[1] (See illustrations.)

Headdresses of this character are still worn in a dance popular among the Plains Indians (see exhibits in Plains Hall). It is reasonable to suppose that originally a roach of natural hair was worn and that from this developed the idea of the artificial roach.

Again in the north the hair was gathered into a knot at the back of the head. In the south, on the other hand, the knot was drawn

[1]Willoughby, C. C.," Dress and Ornaments of the New England Indians" (*American Anthropologist*, N. S. vol. 7, pp. 499-508, 1905), 505.

up on top of the head. In the Upper Mississippi Valley and around the Great Lakes the men wore the hair long and braided.

As we have stated, the women throughout wore the hair long and hanging down or braided. In early times, in the north as well as the

Fig. 3. Fox and Sauk Indians about 1840, with Hair shaved except for a Stubby Roach to which is attached an Artificial Roach of Deer Hair. After Maximilian.

south, the front hair was sometimes cut off like "bangs." Some of the young men of the Upper Missouri practised a form of this in Catlin's time.

Headbands and Feathers. If the reader will consult the successive cases in the Woodland Hall, it will appear that a black headband set with a row of feathers is the rule. Now it so happens that one of the early writers states that many wore such bands of skins dyed black.

Perhaps then what we see in museum collections is merely a change from skin to cloth, adding ornaments of trade beads.

> A very curious diadem or band, about four inches broad, and ingeniously wrought or woven, and curiously decorated with stones, beads, wampum, porcupine quills, etc., encircles their temples; the front peak of it being embellished with a high waving plume, of crane or heron feathers.[1]

Fig. 4. A Mohawk Indian showing Hair Dress and Toga-like Garment. Colonial Period. Jeffreys Collection.

The unusual turban-like cap (modern), still worn by the Seminole, reminds one of Old World styles, from which source it may have been derived.

Feather Hats. During the period 1800-1900 the feather hats of the Siouan tribes and their neighbors have been the most conspicuous. We do not know that they were so large and handsome before 1800, probably they were much smaller then. Anyway, it is certain that the coming of the horse stimulated their elaboration.

[1]Bartram, William, *Travels through North and South Carolina, Georgia, East and West Florida, the Cherokee Country, the Extensive Territories of the Muscogulges or Creek Confederacy, and the Country of the Chactaws* (London, 1792), 499-500.

The feather headgear of the Forest Indians was different; it had no tail, but did circle the head. Both eagle and turkey feathers were used. They stood erect, rather than drooping backward as in the Plains.

In the south the hair was more frequently gathered on top of the head in a knot and from the old drawings it seems that a kind of band, or chaplet, was worn, into which feathers were stuck. This is no doubt the original form of the feather hat.

Fig. 5. King Philip. A portrait of the time from which it appears that this famous chief wore a shirt of European style and presumably of cloth. Otherwise, the costume follows aboriginal lines. After Thomas, Elementary History of the United States.

Ornaments. Tying things to the hair was universal, but aside from feathers, individuality prevailed to such an extent that it is well nigh impossible to treat the subject here. Skins of birds, claws of animals, shells, etc., were used according to the taste or superstition of the wearer.

a

b

Fig. 6. a, A Mexican Indian wearing a Cape and Skirt of Turkey Feathers. The headdress is probably Spanish in origin, but the feather garments are similiar to those of Indians in Eastern United States; b, A Delaware Indian of the Colonial Period wearing Aboriginal Headdress. From old prints, Jeffreys Collection.

Boring the ears seems to have been universal and especially in the south the lobe was greatly distended for the insertion of large disks and ornaments. Speaking of the Southern Indians, Jones states:—

Not only were the ears slit for the reception of inflated bladders, eagles' claws, feathers and various ornamental pendants, but in some instances the nipples and under lips were bored so that canes and other matters for personal adornment might be introduced and worn. The nose was perforated to admit of the suspension of ornaments from the cartilaginous wall which separates the nostrils. It would appear

that lip-stones (called by the Spanish *bezote* and by the Mexicans *teutetl*) were worn, at least to a limited extent.[1]

The bladders mentioned are shown in De Bry's plates.

In New England the ears were pierced, but not so distended, the ornaments being smaller, and the same can be said for the tribes westward into the Plains. The nose was rarely pierced, nor is their evidence

Fig. 7. Headdress of Drooping Feathers. A Museum specimen collected from the Sioux Indians in 1838.

for the labret, these being characteristic of the south. Nevertheless, in the extreme western limit of the Plains are the Nez Percé Indians, who did perforate the nose as did some of their neighbors.

Beads were chiefly of shell, pearl, and occasionally of copper. Apparently all such ornaments were rare and costly and so limited to the favored few, but the coming of the trader with new tools, etc., quickly cheapened beads and made them universal. Speaking of wampum

[1]Jones, C. C., *Antiquities of the Southern Indians* (New York, 1873), 88.

Bradford wrote in 1627 that its use was limited to "ye sachems and some spetiall persons that use a little of it for ornament," but a little later it became plentiful and cheap.

The use of face paint was universal, but tattooing seems to have been most intense in the south, as some old sketches show the chiefs tattooed from head to foot like Polynesians. Some of the chiefs in New

Fig. 8. The First Sketch Shows the Winter Garment for Southern Indians, merely a Rectangular Robe of Dressed Skin hanging over the Left Shoulder. The Second, the Ceremonial Dress of the Same Region, a Small Apron Before and Behind. John White, 1585.

England were also so adorned and so were they in parts of the Plains. But the elaborate tattooing disappeared quickly with the adoption of Colonial costumes. Even in aboriginal times tattooing seems to have declined as one moved northward, for, where the body was well covered part of the year, tattooing would serve no good purpose. A moderate amount of face tattooing was well nigh universal.

Under Garments

The breechcloth was universal for men, and for the most part, women also. A Dutch writer in 1671 says: "The men wear between the legs a lap of duffels cloth, or leather, half an ell broad and nine quarters long; so that a square piece hangs over the buttocks and in front of

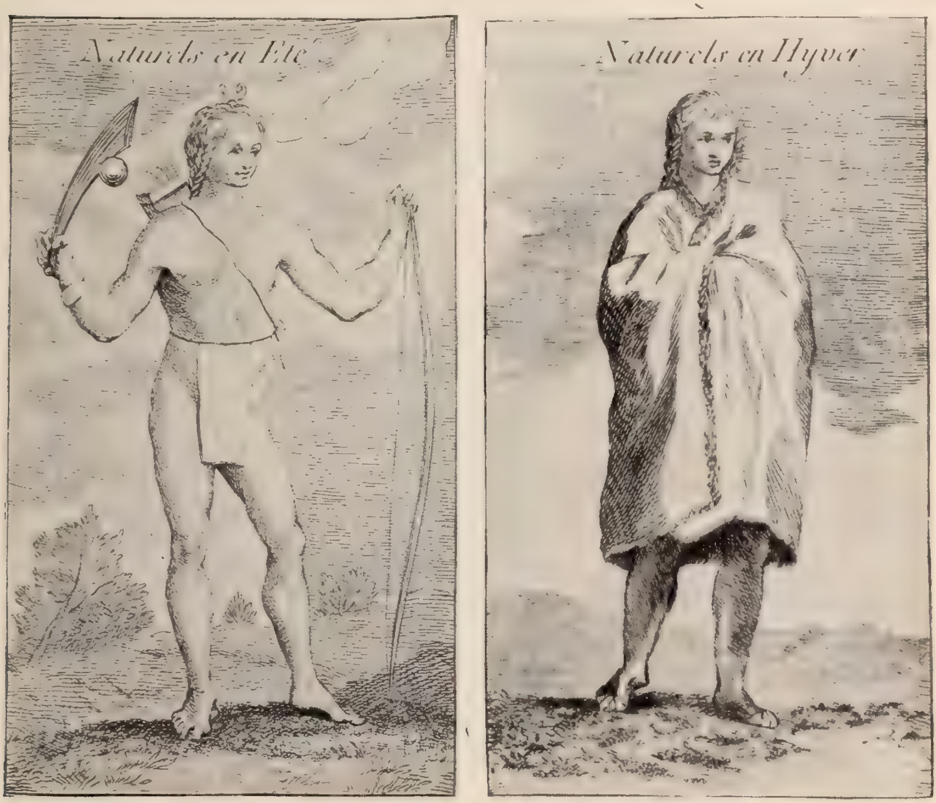

Fig. 9. An Old Print contrasting the Summer and Winter Costumes in Louisiana. After Du Pratz.

the belly." With few exceptions this will hold for all tribes in the United States east of the Rocky Mountains.

According to White's sketches both women and men in Virginia wore a kind of apron before and one behind, but one cannot make out whether these are the ends of the breechcloth, or an additional garment.

Skirts. The women in New England usually appeared in Colonial times with a short skirt formed by wrapping a skin around the waist. This rarely came below the knee. Such seems to have been the original form of the Algonkian, or Eastern, slit skirt, which appears in Colonial times in cloth. (See exhibits.) Such a skirt is merely a rectangular piece brought around the waist, and its use seems to have extended out

Fig. 10. Costumes of Southern Indians from Drawings by John White, 1585.

across the Mississippi and down into the South. Yet along the Gulf some weaving was practised, for we are told that the aprons or skirts were sometimes of native woven stuffs.

Upper Garments

In the house and in mild weather, the Indians wore nothing above the waist line,—men and women the same. As stated before, no good evidence exists that a coat or jacket with sleeves was used below the Canadian border.

In New England and the Central States jackets and shirts appear early in Colonial times, but the styles indicate European origins. It may be, however, that a kind of sleeveless poncho was worn, as reported by Parker.[1] The accounts of the Dutch indicate that originally sleeved garments were unknown.

Fig. 11. Female Costumes in Southern United States. The garment is shown as a rectangular piece of dressed skin. After Du Pratz.

Robes. Instead of jackets, shirts, and coats, both men and women wore, when needed, a robe.

Mantles or robes were made of the skins of the moose, deer, bear, beaver, otter, raccoon, fox, and squirrel, and were worn by both sexes. Beautiful cloaks were manufactured of the iridescent feathers of the wild turkey, 'woven with twine of their own

[1]Anthropological Papers, American Museum of Natural History, vol. 17, part 2, 80.

making,' so that nothing could be seen but feathers. These cloaks were usually the work of the old men, but sometimes were made by the women for their children.

When in the vicinity of Wellsfleet harbor, Massachusetts, Champlain saw robes woven of 'grass and hemp scarcely covering the body and coming down only to the

Fig. 12. Woman and Girl of the Plains. The woman is muffled in a painted robe of buffalo skin. The girl's dress is a replica of the prevailing style for women in 1840. After Maximilian.

thighs.' These were probably identical with the silkgrass mantles of the southern Algonquians illustrated by John White in 1585.

A single skin of the moose, deer, or bear served for a man's robe. Moose skins were commonly dressed without the hair and were made 'wondrous white.'[1] . . .

[1]Willoughby, *ibid.*, 502-503.

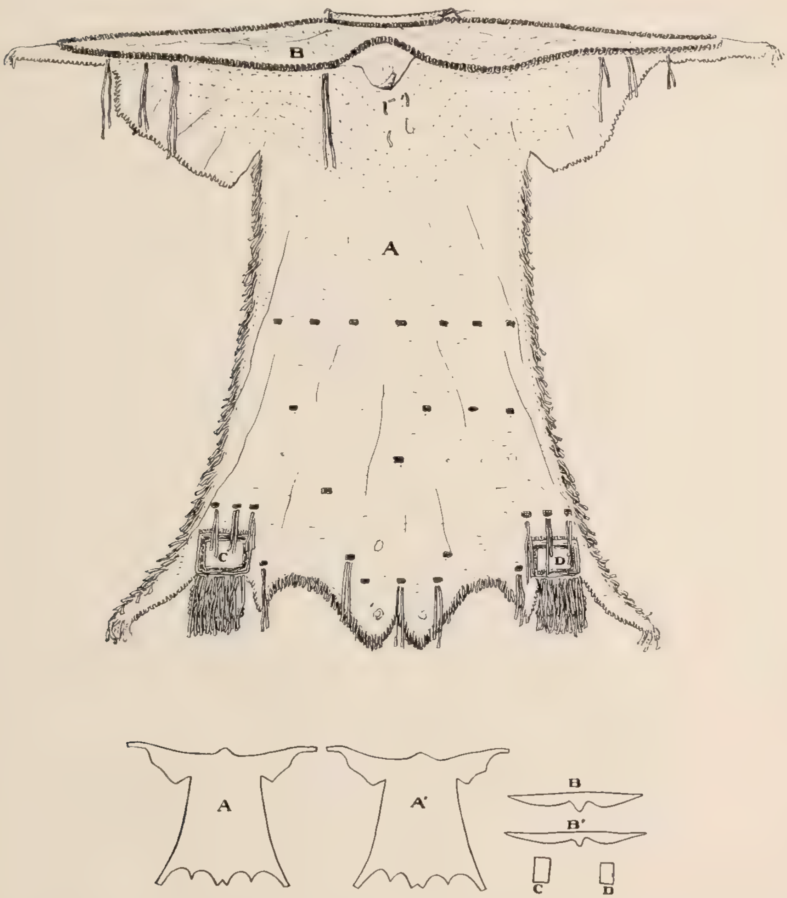

Fig. 13. A Woman's Dress, Crow. An entire elkskin is taken for each side. A cape-like yoke is formed of two pieces as above, and sewed in place. It is interesting to note that the form of dress follows the natural contours of the skin.

Deer-skin mantles were dressed with or without the hair, and a perfect tail greatly enhanced their value. In winter the hair was worn innermost. Those especially prepared for summer wear were dressed usually without the hair. These garments were fastened at the shoulders with leather. They were thrown over one or both shoulders and brought usually under one arm. When traveling they were also secured at the waist with a belt.[1]

[1]Willoughby, *ibid.*, 504.

A long robe fastened at the right shoulder by a knot, at the waist by a girdle, served the men and women for an upper ornament, and by night for a bed cover. Both go, for the most part, bare headed.[1]

These descriptions agree with the sketches of White and other early artists, and as we go westward the buffalo robe appears. Thus the robe is about as universal as the breechcloth; together, these comprise the fundamentals in aboriginal dress.

The New England and Virginia way of wearing the robe left one arm exposed, over which was worn a sleeve of fur, or a kind of muff. This was held to the robe or neck by a cord, probably a northern idea, as we shall see.

Mantles of Turkey Feathers. One of the most striking garments of the Atlantic Coast was a cape, or mantle, of turkey feathers. Such were worn from New England southwestward to California. Not a single specimen has been preserved and they seem to have disappeared quickly upon the coming of the whites. Yet we hear that a net was "woven with twine of their own making" and the feathers fitted to this so that they hung down naturally. Such garments seem to have been common in Mexico and we are able to reproduce an old drawing here.

Shirts. A type of woman's costume, best observed in the Plains is like a poncho, or shirt, a one piece garment reaching from shoulder to below the knee. There are, however, two rather distinct forms: *a,* the Plains; *b,* the Cree-Ojibway type.

The Plains type is without true sleeves. Taking a Crow specimen as the type (Fig. 13) we see that three pieces of skin are used: an inserted yoke and two large pieces for the skirt. The sides are sewed up from the bottom of the skirt almost to the cape-like extension at the shoulders. There are no sleeves, but the cape-like shoulder piece falls down loosely over the arms. The side seams and the bottom and all outer edges are fringed. The garment has neither front nor back, both sides being the same.

The technical concept is a garment made from two whole skins, in this case, elkskins. A dress is formed by placing two whole skins face to face, the tail ends at the top, the head at the bottom. The neck is fitted and the yoke formed by the insertion of a transverse piece of skin. Very little trimming is needed to shape the sides of the skirt.

The distribution of this pattern concept so far as we were able to determine by the study of specimens is: Apache, Arapaho, Assiniboin,

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[1]Skinner, Alanson, *The Indians of Greater New York* (Cedar Rapids, Iowa, 1915), 22, quoted from O'Callaghan, *Documentary History of New York.*

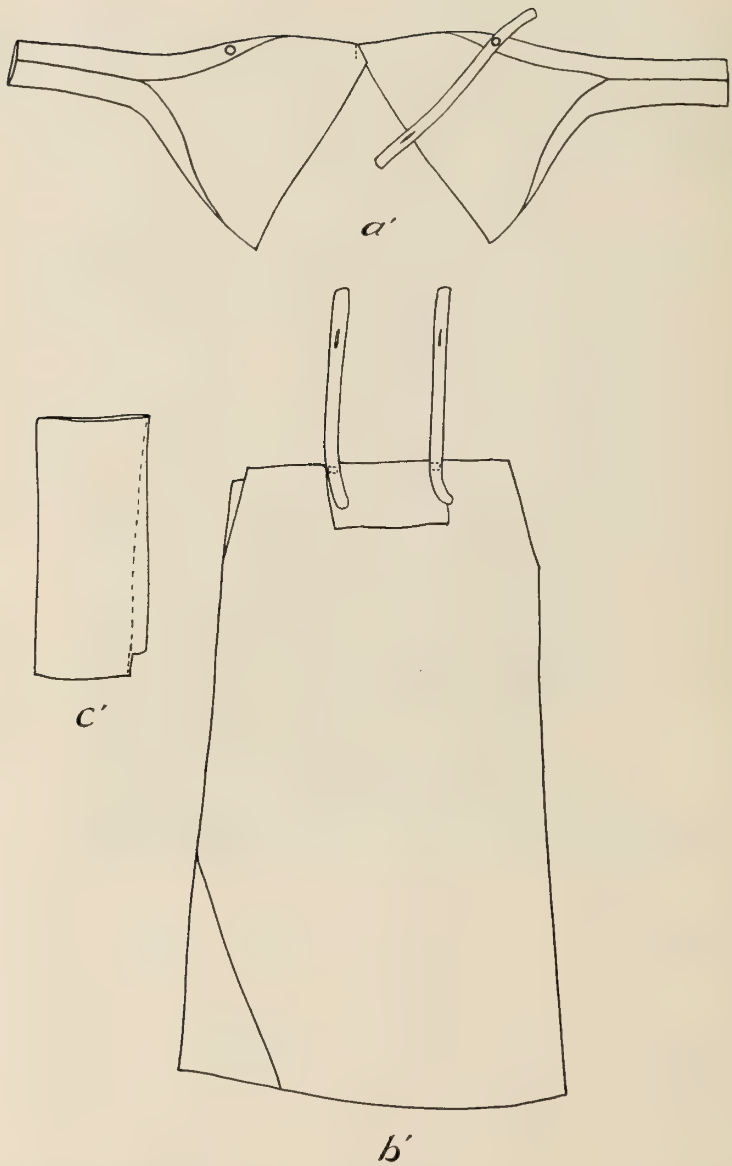
Blackfoot, Cheyenne, Comanche, Crow, Dakota, Gros Ventre, Hidatsa, Kiowa, Nez Percé, Northern Shoshoni, Plains-Cree, Sarsi, Ute, Yakima.

In the Cree-Ojibway type the shoulder cape is missing, thus leaving a skirt, supported over the shoulders by straps, or the edges of the skin tied together.

Fig. 14. Sketch of an Ojibway Girl of about 1850. The style of dress intended to be portrayed, is a simple sleeveless garment supported by straps over the shoulders. The separate cape-like sleeves are also shown. After Schoolcraft.

The coat, or body covering, falls down to the middle of the leg, and is fastened over the shoulders with cords, a flap or cape turning down about eight inches, both before and behind, and agreeably ornamented with quill-work and fringe; the bottom is also fringed, and fancifully painted as high as the knee. As it is very loose, it is enclosed round the waist with a stiff belt, decorated with tassels, and fastened behind. The arms are covered to the wrist, with detached sleeves, which are sewed as far as the bend of the arm; from thence they are drawn up to the neck, and the corners of them fall down behind, as low as the waist.[1]

[1]Mackenzie, Alexander, *Voyages from Montreal, on the River St. Lawrence, through the Continent of North America, to the Frozen and Pacific Oceans, in the years 1789 and 1793, etc.* (London, 1801), XCIV.



a′

c′

b′

Fig. 15. Pattern of a Deerskin Dress from the Saulteaux Indians, similiar to the One shown in the Sketch of an Ojibway Girl.

These sleeves held by a cord remind one of the men's sleeve in the east, to which they certainly have some relation.

On dress occasions the distinguished men of the Plains wore shirts, also made of deerskins (Fig. 16). In this case, however, the forequarters of the skin are cut off and sewed to the sides forming an open sleeve as

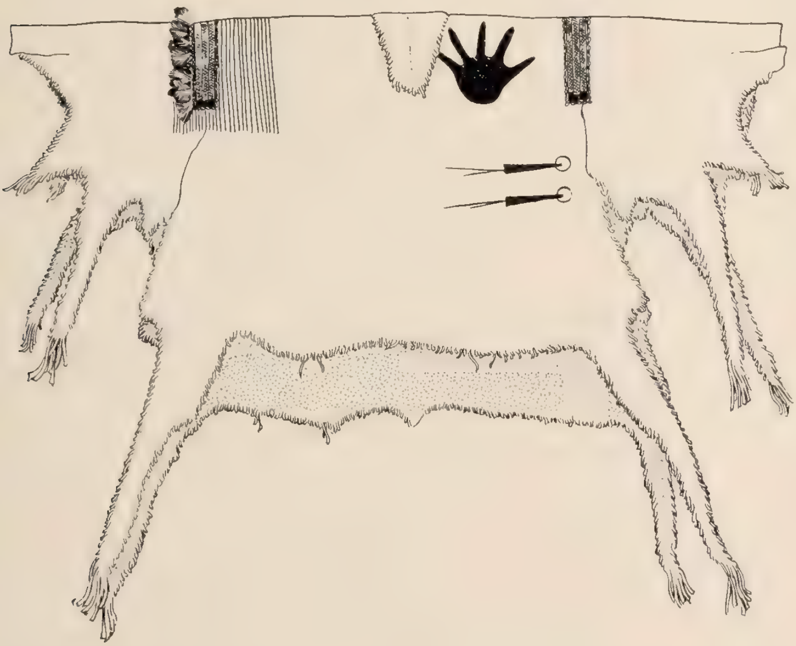


Fig. 16. A Man's Shirt of the Poncho Type. This specimen is made of two deerskins. There are bands of quillwork over each shoulder, fringed on one side with crow feathers. On the opposite side of the fold is a transverse band of quillwork. See Bulletin of this Museum, vol. 18, fig. 95. The tail tuft is discernible on the lower edge and the dewclaws are still attached to the leg projections. Collected in 1838.

for women. More modern specimens have the lower part of the sleeve closed. All the Plains tribes used this shirt, as well as the Apache and Taos on the south and the Ojibway on the northeast. They vary somewhat in decoration as may be seen in the exhibits.

We repeat that these shirts were only worn on special occasions and by a few men; otherwise, except in the northeastern Plains, no upper garments were worn.

Wallets

In addition to the belt for holding the breechcloth, a girdle was often used to hold the robe. To this were attached useful objects, but special mention should be made of pouches.

The men wore at the girdle a pouch of dressed skin containing fire-making implements. A pipe and tobacco were also carried in the pouch, which was sometimes suspended from the neck.[1]

Fig. 17. A British Footguard, 1745. A comparison of the bandolier on this figure with those in the Indian collections is suggested. Sketch from Grant's "British Battles".

The pouch offered a field for decoration and among the Plains Indians became a very important feature of formal dress.

Among the collections from the Forest tribes one may note large showy pockets with shoulder bands, sometimes called "bandoliers." These are assumed to be of European origin, but still appear very early in Colonial days. The form of this pocket closely parallels that used by soldiers of the period (Fig. 17) as seen in the illustration. These very decorative articles must then be regarded as innovations in Indian costume and not mere adaptations.

Footgear

The footgear of the Indian is far better known than other parts of his costume. A moccasin was worn throughout the forests and the plains; but along the Pacific Coast, from Alaska to Mexico, the people went barefoot most of the time. In the desert lands of the Southwest and in Mexico sandals were worn. Our present concern then is with the moccasin. The earliest pictures of Indians from Virginia to the south show everybody barefoot, but we are told that moccasins were often worn. On the other hand, from Virginia northward moccasins were the rule.

Leggings were used by both sexes, especially in the north, but for a true boot one must go to the Eskimo. In New England and apparently in all the upper Mississippi region, the men wore a long legging reaching far up on the thigh and held by a string to the belt, supporting the breechcloth.

[1]Willoughby, *ibid.*, 505.

In addition to the breech-clout it was customary for the men, and sometimes for the boys, to wear close-fitting leggings of tanned deer skin. These were worn for warmth in cold weather, on dress occasions, and by hunters as a protection from brush and briers. Their lower ends were fastened within the moccasins and their upper extremities were secured by straps to the girdle, which was sometimes ornamented with pendants or 'set with forms of birds or beasts.' The leggings were ornamented with designs in yellow, blue, and red. The women also sometimes wore leggings.[1]

This description, culled from old writers, is repeated by the Dutch observers and if one views the collections in the Museum it will be seen to hold for all tribes east of the Rockies. The leggings for women rarely come above the knee and were held up by a string garter.

Moccasins. The local types of moccasins have been carefully studied by Mason and Hatt.[2] In the main the moccasins of the forest had a soft sole, like a stocking; while those of the plains had a stiff sole like a slipper. The body of the former was made of a single piece of skin with the folds and seams on top of the foot and what varieties are found are produced by change in the flap and seams. So, in the main, the form shown in the figure (5) will serve for all the tribes east of the Mississippi. The flaps can be worn down or up.

The moccasin was also subjected to decoration and as such is one of the most conspicuous parts of an Indian's costume. The design usually follows the seams, covers the tongue insert, and the flaps. Seldom are the other surfaces of the moccasin ornamented.[3]

Turning now to the Plains we meet with a soled moccasin, in reality a shoe, but with no heel. The patterns for this type resemble those for shoes and need not be explained. In decoration there are some differences, for now there is a sole line at the side of the foot. This is often ornamented. Yet, in the main, the styles of moccasin designs found in collections from the Plains, are similar to those from the forests; hence, we infer that the Plains type is the more recent.

On the other hand, the practice of beading or quilling the entire surface of the moccasin is peculiar to the Plains, and is also recent.

In both the forests and the plains, there is little distinction in pattern between the moccasins of women and men.

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[1]Willoughby, *ibid.*, 502.

[2]Mason, O. T., "Primitive Travel and Transportation" (*Report, United States National Museum for 1894*, Washington, 1896); Hatt, Gudmund, "Moccasins and their Relation to Arctic Footwear" (*Memoirs, American Anthropological Association*, vol. 3, no. 3, 1916).

[3]Wissler, Clark, "Structural Basis to the Decoration of Costumes among the Plains Indians" (*Anthropological Papers, American Museum of Natural History*, vol. 17, part 3, 1916).

Early Accounts

A fair idea of Virginia costume is given by John Smith, as follows:—

For their apparell they are sometimes covered with the skinnes of wilde beasts which in Winter are dressed with the hayre, but in Summer without. The better sort vse large mantels of Deare skins, not much differing in fashion from the Irish mantels. Some imbroidered with white beads, some with Copper, other painted after their manner. But the common sort haue scarce to cover their nakednesse but with grasse, the leaues of trees or such like. We haue seene some vse mantels made of Turky feathers, so prettily wrought and woven with threads, that nothing could be discerned but the feathers. That was exceeding warme and very handsome. But the women are alwayes covered about their middles with a skin, and very shamefast to be seene bare. They adorne themselues most with copper beads and paintings. Their women, some haue their legs, hands, breasts and face cunningly imbrodered with divers workes as beasts, serpents, artificially wrought into their flesh with blacke spots. In each eare commonly they haue 3 great holes, whereat they hang chaines, bracelets, or copper. Some of their men weare in those holes a small greene and yellow coloured snake, neare halfe a yard in length, which, crawling and lapping her selfe about his necke, oftentimes familiarly would kisse his lips. Others weare a dead Rat tyed by the taile. Some on their heads weare the wing of a bird or some large feather with a Rattell. Those Rattels are somewhat like the chape of a Rapier, but lesse, which they take from the taile of a snake. Many haue the whole skinne of a Hawke or some strange foule, stuffed with the wings abroad. Others a broad peece of Copper, and some the hand of their enemy dryed. Their heads and shoulders are painted red with the roote *Pocone* brayed to powder, mixed with oyle, this they hold in sommer to preserue them from the heate, and in winter from the cold. Many other formes of paintings they vse, but he is the most gallant that is the most monstrous to behold.[1]

Speaking of the moccasins of the Southern Indians, Jones states:—

The shoes of the men and women were fashioned after the same pattern, and were seldom worn except upon a journey. They were made of deer-skin, the sole and upper leather being of the same piece, and sewed together on the upper part of the foot. The moccasin was cut about three inches longer than the foot, and folded over the toes. The quarters were about nine inches high, and fastened round the leg like a buskin.[2]

Of the women's costume of the Indians living in the vicinity of New York, O'Callaghan in his *Documentary History of New York*, writes:—

The women ornament themselves more than the men. And although the winters are very severe, they go naked until their thirteenth year; the lower parts of the girls' bodies only are covered. All wear around the waist a girdle made of a fin of a whale or of seawant (wampum). . . The women wear a petticoat midway down the leg, very richly ornamented with seawant. . . They also wrap the naked body in a deer skin, the tips of which swing with points . . . . The women bind their hair in a plait, over which they draw a square cap, thickly interwoven with seawant.[3]

[1]Quoted in Jones, *ibid.*, 76-77.
[2]Jones, *ibid.*, 79.
[3]Quoted by Skinner, Alanson, *The Indians of Greater New York* (1915), 22.

CALIFORNIA

The standard clothing of California, irrespective of cultural provinces, was a short skirt or petticoat for women, and either nothing at all for men or a skin folded about the hips. The breechclout is frequently mentioned, but does not seem to have been aboriginal. Sense of modesty among men was slightly developed. In many parts all men went wholly naked except when the weather enforced protection, and among all groups old men appear to have gone bare of clothing without feeling of impropriety. The women's skirt was everywhere in two pieces. A rather narrow apron was worn in front. A larger back piece extended around at least to the hips and frequently reached to meet the front apron. Its variable materials were of two kinds: buckskin and plant fibers. Local supply was the chief factor in determining choice. If the garment was of skin, its lower half was slit into fringes. This allowed much greater freedom of movement, but the decorative effect was also felt and used. Of vegetable fibers the most frequently used was the inner bark of trees shredded and gathered on a cord. Grass, tule, ordinary cordage, and wrapped thongs are also reported.

As protection against rain and wind, both sexes donned a skin blanket. This was either thrown over the shoulders like a cape, or wrapped around the body, or passed over one arm and under the other and tied or secured in front. Sea otter furs made the most prized cloak of this type where they could be obtained. Land otter, wild cat, deer, and almost every other kind of fur was not disdained. The woven blanket of strips of rabbit fur or bird skin sometimes rendered service in this connection, although also an article of bedding.[1]

Moccasins "were not worn about the village or on ordinary excursions." Yet they were made and of the general forest type. In Southern California, however, sandals were used.

The typical California moccasin, which prevailed over central and northwestern California, was an unsoled, single-piece, soft shoe, with one seam up the front and another up the heel . . . The front seam is puckered, but sometimes with neat effect. The heel seam is sometimes made by a thong drawn through. . . Separate soles of rawhide are sometimes added, but old specimens are usually without, and the idea does not seem to be native. The moccasin comes rather higher than that of the Plains tribes, and appears not to have been worn with its ankle portion turned down. Journeys, war, wood gathering are the occasions mentioned for the donning of moccasins; as well as cold weather, when they were sometimes lined with grass. They were not worn about the village or on ordinary excursions. . . .

The skin legging is rarer than the moccasin. It was made for special use, such as travel through the snow.[2]

Two somewhat unique features are a netted cap for men and basket caps for women. The latter occurs in northern California extending upward to Washington; the former is found chiefly where the basket cap is wanting.

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[1]Kroeber, A. L., "Elements of Culture in Native California" (*University of California Publications in American Archæology and Ethnology*, vol. 13, no. 8, 1922), 260-261.

[2]Kroeber, A. L., "Handbook of the Indians of California" (*Bulletin 78, Bureau of American Ethnology*, Washington, 1925), 805, 807.

WASHINGTON AND OREGON

With respect to the tribes in the valley of the Columbia River, near the coast, it is stated:—

> The clothing used by the natives of this area was relatively simple. The men either wore nothing at all or merely a robe or blanket thrown over the back and fastened across the chest with a string. The women wore a sort of petticoat made of twisted strings of cedar-bark or grass, occasionally of wool, fastened to a cord or band around the waist and falling to the knees. In addition to this they usually wore a robe, smaller than that worn by the men, over the back. Among the Yakonan a similar fringed garment was worn around the shoulders. A hat, usually woven of cedar-bark and grass, was frequently worn, especially in wet weather, when it was also customary to throw a mat over the shoulders for further protection.
>
> The hats of the Chinook and neighboring tribes . . . . were closely woven of cedar-bark and grass with some fine cedar-root, so as to be water-tight, and were of a conical shape, surmounted by a pointed knob some two to four inches in diameter. They were ornamented with interwoven designs representing whaling scenes, animals such as dogs and deer, or purely geometrical designs. . . .
>
> The robes and blankets used in this area were usually made of the skins of various animals, or woven (twined) from the wool of the mountain goat. While these were more common northward, woolen robes were also made on the Columbia. . . .
>
> Tattooing occurs to but a slight extent among these tribes, and is usually limited to a few lines or dots on the arms or legs, apparently according to individual fancy. It is more prevalent among the women than the men. The face is rarely, if ever, marked.
>
> Ornaments were commonly worn by both sexes, but especially by the women. Nose and ear ornaments, necklaces, etc., were worn, though it is doubtful if nose ornaments were used by the tribes of Puget sound. Most of these were made of shells, dentalia being the most valued. These form, in fact, one of their most valued possessions, and also serve as a circulating medium.[1]

Usually all these Indians were barefoot.

In the interior, among such tribes as the Yakima, Nez Percé, etc., we find the above type of costume fading out into that of the Plains. Further, since the boundary between the United States and Canada is an arbitrary line, we need not be surprised to find that both the coast and interior types extend into British territory. The Indians of Alaska have a variant of the coast type (see exhibits in the Museum).

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[1]Lewis, Albert Buell, "Tribes of the Columbia Valley and the Coast of Washington and Oregon" (*Memoirs, American Anthropological Association*, vol. 1, part 2, 1906), 165, 166, 168.

THE SOUTHWEST

The California type of costume, or want of costume, spreads into Arizona and the Plains type crowds in from the west, as among the Apache; but the Pueblos stand out as rather distinct. This is chiefly due to the presence of woven materials, but when they do resort to skins they tend toward Plains types, except that their moccasins are more like

Fig. 18. Girls from Sia Pueblo in New Mexico. After Mrs. Stevenson.

boots. The women in many villages wear a boot whose top is wrapped around the leg to the knee. Sandals were, however, the usual footgear.

The older woman's costume seems to have been without sleeves, but fastened over the right shoulder, leaving the left free. A sash was used instead of a belt. A rectangular robe might be thrown over the shoulders. No hats were used.

The fabrics were woven of cotton and later of wool. Yet, in aboriginal days, robes were sometimes woven of strips of rabbitskin and also the turkey feather mantles used in southern and eastern United States were common.

The men usually cut their hair (bobbed) and wore a band around the head. It is not clear as to the existence of a poncho, or shirt, that seemingly came in with the Spaniards; the essential costume was a short kilt and a mantle or a skin robe.

Quoting from the earliest Spanish accounts, we read:—

Cibola is seven villages. The largest is called Macaque. The houses are ordinarily three or four stories high, but in Macaque there are houses with four and seven stories. These people are very intelligent. They cover their privy parts and all the immodest parts with cloths made like a sort of table napkin, with fringed edges and a tassel at each corner, which they tie over the hips. They wear long robes of feathers and of the skins of hares, and cotton blankets. The women wear blankets, which they tie or knot over the left shoulder, leaving the right arm out. These serve to cover the body. They wear a neat well-shaped outer garment of skin. They gather their hair over the two ears, making a frame which looks like an old-fashioned head-dress.[1]

In their houses they keep some hairy animals, like the large Spanish hounds, which they shear, and they make long colored wigs from the hair, like this one which I send to Your Lordship, which they wear, and they also put this same stuff in the cloth which they make. The men are of small stature; the women are light colored and of good appearance, and they wear shirts or chemises which reach down to their feet. They wear their hair on each side done up in a sort of twist, which leaves the ears outside, in which they hang many turquoises, as well as on their necks and on the wrists of their arms. The clothing of the men is a cloak, and over this the skin of a cow, like the one which Cabeza de Vaca and Dorantes brought, which Your Lordship saw; they wear caps [probably headbands] on their heads; in summer they wear shoes made of painted or colored skin, and high buskins in winter.[2]

Some of these people wear cloaks of cotton and of the maguey (or Mexican aloe) and of tanned deer skin, and they wear shoes made of these skins, reaching up to the knees. They also make cloaks of the skins of hares and rabbits, with which they cover themselves. The women wear cloaks of the maguey, reaching down to the feet, with girdles; they wear their hair gathered about the ears like little wheels.[3]

[1]Winship, George Parker, "The Coronado Expedition, 1540-1542" (*Fourteenth Annual Report part I, Bureau of American Ethnology*, Washington, 1896), from *Translation of the Narrative of Castañeda*, 517.

[2]Winship, *ibid.*, from *Translation of the letter from Mendoza to the King*, April 17, 1540, 549.

[3]Winship, *ibid.*, from the *Relación Postrera de Sivola*, 569.

THE USE OF CLOTH

As stated elsewhere, among the first articles to be offered the Indians, were cloth, shoes, boots, etc. At first, the tendency was to cut the cloth to the patterns for the old skin garments, as a study of the collections will make clear; but eventually the coats, shirts, etc., of the whites introduced new styles. Very early, indeed, the Iroquois took to cotton shirts and coats of buckskin, with brass buttons. The women were a little more conservative, but quickly adopted the waist with sleeves.

Fig. 19.—Winnebago Indians. These costumes contain both native materials and trade cloth; in pattern they are hybrids.

In the Ojibway collection are to be found cloth dresses without sleeves, made after the pattern of Fig. 15. The Iroquois and other eastern women wore a skirt formed by wrapping a rectangular piece of cloth around the body, examples of which are on view. Even in the Plains, cloth dresses are to be found.

SOURCES OF INFORMATION

The ideal procedure in the study of costume is to examine the collection in a well stocked museum, but even then it will be necessary to take the literature into account. Thus, if one wishes to know the dress of a given tribe, say the Seminole, he should turn to that title in the *Handbook of American Indians*,[1] where he will find titles of the most important publications. Then, if the dress of a known historical period is desired, that can also be determined. Finally, if the notes thus secured are taken as the basis for a study of museum collections, one will have exhausted all the available sources.

Among general works, the following will be found useful:—

Bry, Theodoro de. Brevis narratio eorum qvæ in Florida Americæ Provicia Gallis acciderunt, secunda in illam nauigatione du ce Renato de Laudoniere classis Praefecto anno M. D. LXIII, qvæ est secvnda pars Americæ. Francoforti ad Mœnvm, 1591.

Catlin, George. Illustrations of the Manners, Customs and Condition of the North American Indians. 2 vols. New York and London, 1848.

Champlain, Samuel de. Voyages; ou Journals es decouvertes de la Nouvelle France. Tomes I-II. Paris, 1830.

Hariot, Thomas. A Briefe and True Report of the New Found Land of Virginia of the Commodities and of the Nature and Manners of the Naturall Inhabitants. Folis Frankoforti ad Mœnum, 1590.

Jeffreys, T. Collection of the Dresses of the Different Nations (etc.). the complete American Indian portion, being plates 121 to 240. London, 1757-72.

Lafitau, J. F. Mœurs des Sauvages Americains, comparees aux Mœurs des Premiers Temps. Tomes I-II. Paris, 1724.

Maximilian, Prince of Wied. Travels in the Interior of North America. Translated from the German by H. Evans Lloyd. London, 1843.

McKenney, Thomas L. and Hall, James. History of the Indian Tribes of North America, with biographical Sketches and Anecdotes of the Principal Chiefs. Embellished with One Hundred and Twenty Portraits from the Indian Gallery in the Department of War at Washington. Philadelphia, 1837-44.

Schoolcraft, Henry R. Historical and Statistical Information respecting the History, Condition, and Prospects of the Indian Tribes of the United States: Collected and Prepared under the direction of the Bureau of Indian Affairs. Vols. 1-6. Philadelphia, 1851-1857.

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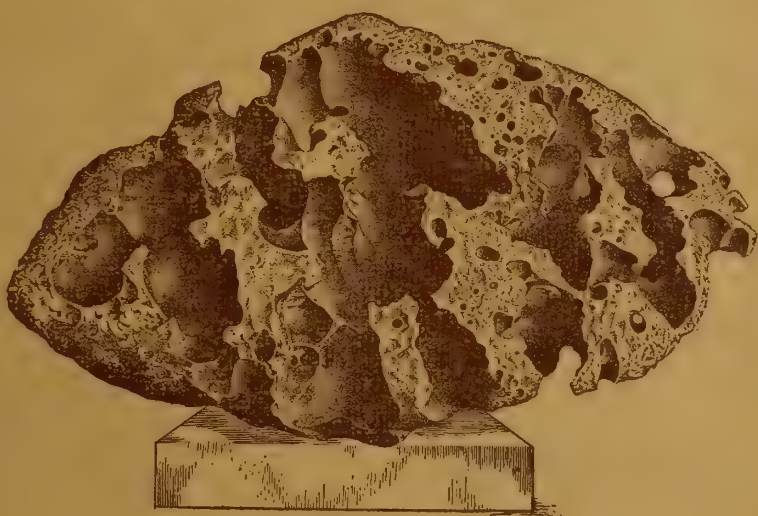
[1]Bulletin 30, Bureau of American Ethnology.

THE AMERICAN MUSEUM OF NATURAL HISTORY

METEORITES, METEORS AND SHOOTING STARS



By FREDERIC A. LUCAS

GUIDE LEAFLET SERIES No. 64

THE WILLAMETTE METEORITE
The largest meteorite so far found in the United States and the most interesting yet discovered.
Gift of Mrs. William E. Dodge, 1906.

METEORITES, METEORS
AND
SHOOTING STARS

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When the Willamette Meteorite was brought to the Museum the attendant in the hall where it was placed was the recipient of many inquiries from interested visitors who wished to know what the (then) unfamiliar object was. Finally, in self defense he placed on it a card "This is a piece of a star" a statement which if not strictly accurate was one that embodied the most information in the fewest possible words. And if sticklers for accuracy complain that this is a very incorrect definition they may be reminded that it is not nearly so misleading as that of the chemist Lavoisier who, so late as 1772, reported on a specimen submitted to a committee of the French Academy, that it was only a common stone that had been struck by lightning. For those who wish an authoritative and brief statement as to what meteorites are one cannot do better than quote from the general label on the meteorites, a label read daily by scores of visitors and an admirable refutation of the mis-statement that visitors won't read long labels—they will, provided the subject is of interest and the label well-written.

To borrow from Dr. E. O. Hovey, meteorites, as we know them, are bodies of iron or stone, ranging in size from particles of dust up to masses of 30 tons weight, that circle through space like little planets. Ordinarily they are too small to be seen, but when they enter the earth's atmosphere, as thousands of them do daily, become visible through being made hot from the friction of the air. The small meteorites burn up when far above the earth and are the familiar "shooting" stars; the larger masses, known as meteors during their glowing passage through the air, often reach the earth as meteorites. These falls are accompanied by dazzling light and usually, or often, by violent explosions, due to the breaking up of the mass, and so loud that they have been heard at a distance of sixty to one hundred miles.

The molten particles given off by meteors as they hurtle blazing through the air fall like rain in the form of minute drops and when this occurs over the ocean these particles sink to the bottom, and at great depths, where not disturbed by currents, this cosmic dust, as it was termed by Sir John Murray, has, in time accumulated in places to form a perceptible, if small, portion of the ocean floor.

Where do meteorites come from? What is their origin? This is something of which we are quite ignorant, though there are some plausible theories concerning them and others not so plausible. Perhaps the most

favored explanation was that meteorites were ejected by volcanoes variously located according to the imagination of the theorist on the earth, the moon or the sun.

As for their earthly origin it was shown that to get them outside the attraction of the earth they must be cast forth with a speed of five miles a second, a much greater explosive force than shown by any volcano, even Krakatoa. The lunar volcanoes have long been extinct and if they were the source of meteorites these must have been ejected ages ago.

In direct opposition to the theory that meteorites *came* from the moon Mr. Grove K. Gilbert advanced the hypothesis that the vast, circular, low-walled craters with which the moon's face abounds might have been caused by the impact of huge meteorites falling on the luminary.

The view, then beginning to be seriously considered, that the Coon Butte Crater was created by a giant meteor may have had something to do with leading Gilbert to consider this theory, but while he showed that there were good arguments in its favor he abandoned it in favor of the theory that the lunar craters were formed by the fall of "moonlets" that had circled about the moon as satellites. Coon Butte "crater" just referred to is supposed to have been formed by the main mass of the Canyon Diablo fall which has already yielded about 16 tons of fragments ranging from the size of a marble up to a little more than a thousand pounds and scattered over an area of several square miles.

Another view, and the one now accepted, is that the crater was not formed by one immense meteor, but by a mass of small meteorites, and just as a charge of small shot, at short range, will smash through a board, so these little projectiles together drove into the earth and formed the crater—this theory accounts for the failure to find a vast iron meteorite and explains the thousands of fragments of various sizes—but mostly small—scattered over a wide area. The steam produced by the intense heat of this mass of meteorites entering the ground also aided in the formation of the crater by blowing out the disrupted rocks.

For many years past work has been carried on at Coon Butte, or Meteor Crater, with the hope of discovering and mining the meteor or meteors, and much capital has been literally sunk in borings for this purpose. Mr. Barringer has been in charge of the work of exploration and his last report, made in January, 1926, announced "Eventually this hole (the last boring sunk through the south rim, it having been determined that the mass approached from the north at an angle of approximately 45°) encountered what is beyond doubt the upper part of the buried cluster of iron meteorites, finding it exactly in the predicted position.

"The work . . . was (thus) successful in locating the hidden meteor and in pointing the way for future exploration."

Mr. Barringer also explains another point; "it has been generally supposed that the search for this meteorite was for the purpose of obtaining a quarry of pure iron," but we are told that "It must not be thought there is expectation of mining solid iron . . . the iron, as iron, would be of little value. It contains, however, enough nickel to render it a valuable ore—from 5 to6 per cent.—and a small, but valuable, amount of some of the platinoid metals."

Still what are meteorites? According to some they are fragments of a lost world, shattered by collision with another that had somehow got out of place. But it must have been a world of strange composition for while analyses of meteorites have yielded no new *elements* yet they have been shown to contain some minerals which are combinations of elements not found upon earth. These are Maskelynite, Schreibersite, Moissanite, Troilite, Daubrielite, Oldhamite.

Yet another idea advanced by men of science was that meteorites were "condensed" out of clouds of dust, particularly from dust ejected by a volcano. This theory was applied to a fall that occurred in Siena in 1794 during an eruption of Vesuvius, but was badly weakened later by the fall of blazing meteors, accompanied by loud explosions, from a cloudless sky.

There is an evident connection between meteorites and comets, especially in regard to their orbits, or the track they pursue through space, but that there is any physical connection between them is doubtful, since comets themselves are regarded as gaseous bodies.

Meteorites seem to have no preference for any particular part of the earth's surface and they fall at any hour of day or night: the large meteors seem also to occur at any time of year, but the smaller meteors, the shooting stars, have periods of great abundance in August and November at intervals of many years. The most noteworthy of these "star showers" took place in 1833 and less notable ones occurred in 1866 and 1867: later appearances have been far less spectacular and it is believed that the influence of other planets may have diverted from its course the stream of small meterors through which the earth passed attracting to its atmosphere the bodies to which the display was due.

Naturally there are some popular beliefs in regard to meteors and some superstitions; that there are not more is probably due to the fact that so few of these visitors from space have in the past been seen to reach the earth. A pleasing belief is that a "shooting star" betokens the

BETYL COINS

1 Seleucia in Syria c. 100 A.D. 2 " c. 200 A.D. 3 " c. 300 A.D.	COPPER	7 Paphos in Cyprus 70 A.D. 8 Mallos in Cilicia 450 A.D. 9 " " " " " 10	SILVER
4 Amulet. Graeco-Roman	GOLD	12 Emisa, Caracalla, Temple of Elagabal at Emisa within conical stone of Elagabal 13 14	COPPER
5 Emisa, 150 A.D. 6 Biblos, 200 A.D.	COPPER		

By courtesy of the American Numismatic Society

death of some one, usually a person of importance, and it is probable that this belief is of very ancient origin, dating back to the time when our lives were influenced by stars and planets. Superstitions, inherited beliefs, are long-lived and die hard; centuries have passed since, according to Scripture, "The stars in their courses fought against Sisera" and we still upon occasion "thank our lucky stars" and speak of people as saturnine or jovial as the case may be.

A very attractive theory is that which assumes that when this earth of ours was taking shape out of chaos after aeons of time the germs of life were brought to it by some meteorite. This has the advantage of putting the origin of life so far away in space and time that we have no facts to interfere with any theories concerning it.

Perhaps the most famous of meteorites is the Black Stone of Mecca, the stone on which one legend has it that Jacob pillowed his head when he dreamed of the ladder reaching from earth to heaven whereon the angels ascended and descended; according to another version it was presented to Abraham by the angel Gabriel, for what purpose we are not told, while iconoclasts claim it to be a very very ancient pagan fetish long ago built into the walls of the Kaaba. We have no records telling of the Black Stone of the Kaaba, but from the writings of Livy, Plutarch and other early historians we know that meteorites were recognized and revered for centuries before the Christian Era and perhaps the excavations in the Roman Forum may some day bring to light one of these sacred stones. And yet, as we have seen, curiously enough the heavenly origin of meteorites was long denied by modern scientists.

As the ancients supposed the stars to be the residences of the gods falling stars, or meteorites, were regarded as signifying the descent of a god, or the sending of his image to the earth. Hence they were received with divine honors, held sacred, and, temples erected for their reception. One of these stones is mentioned in the Acts when the "town clerk" said, "what man is there that knoweth not how that the city of the Ephesians is a worshipper of the goddess Diana and of the image that fell down from Jupiter.[1] Not only were meteorites held to be sacred but medals and coins were struck in their honor or to commemorate their fall, a practice that endured for some six hundred years. It is interesting to note that while originally the effigies on these Betyl coins bore some resemblance to the object they commemorated, as time went on the representation of these heaven sent messengers became more and more human like. Also, judging by the number of "tokens"

[1]Acts, XIX, 35.

struck, the collection of Dr. Brezina, of the Vienna Museum, numbers several hundred, one can not help feeling that then, as now, many objects were considered as falling stars that had no claim to that designation.

The custom of placing objects in temples endured into the Christian Era and—in the shape of votive offerings—is still in vogue—so it is not surprising that the first meteorite actually seen to fall, the major portion of which is still preserved, was placed in a church where it remained for many years. This historic meteorite fell at Ensisheim, Alsace, between eleven and twelve of the morning of November 16, 1492, and a piece of it was included in the Ward-Coonley collection now incorporated in that of the Field Museum.

There are various popular errors in regard to meteorites the most common being that they are intensely hot when they strike the earth, a very natural error since we see them traversing the air in a blaze of fire. So far from this being the case they may be very cold, the Colby, Wisconsin, meteorite for instance was covered with frost when found shortly after its fall, although this occurred on July 4th. Why they are not hot is explained by Elihu Thomson in his consideration of Meteor Flight, which also explains some of the external features of meteorites

"Innumerable meteoric bodies enter the earth's atmosphere daily from outside space, but few of these "shooting stars" ever reach the earth's surface, because the atmosphere forms a sheath protecting us from them. If the velocity of a body entering the air is very high as compared with that of the earth, for example, 30 or 40 miles per second, the resistance offered by the air in front of it may be great enough to break it into fragments or crush it, while the high temperature given to the air thus compressed progressively melts and vaporizes the outer surface of the mass and then of its fragments. Thus, meteorites in their atmospheric flights are virtually subjected to a highly heated blast of strongly compressed air. Magnetic (the black) oxide of iron, which is formed by this burning of the metal in oxygen or air, is more fusible than iron itself, and it is swept back from the surface of a moving meteorite as fast as it is formed, much of it in spray or drops, but some of it in the state of vapor in the trail which marks the course of the body in the air Melted, pear-shaped drops have, in fact, been observed in and falling from the train of slowly moving iron meteorites. If the meteoritic mass survives its passage through the air, it retains a thin, shiny, black skin over its surface composed of the iron oxide, or of glass containing iron oxide, in the case of the stony meteorites.

An important point to be understood from the foregoing is that the

energy appearing as heat is not transmitted to the body of the meteorite as such, but is dissipated in the air along with the oxide layer continuously formed, ripped off and left behind in the meteorite's path. Before the mass enters our atmosphere, its temperature is that of the space around it (absolute zero, or –460° F.), and its flight through the air lasts for such a short time, that the heat generated on the outside, though very intense, does not enter its interior. For comparison, when we turn a vigorous blast of hot gas, as a blowpipe flame, on a block of ice, the ice melts rapidly, the water on its surface is blown off as fast as formed, but what remains is always ice.

If of somewhat rounded form, the meteorite may have rotated in the air, presenting all sides in succession to the corrosive wasting by combustion. If of irregular or elongated form, rotation would be checked, the body would advance in a position resulting from a balanced resistance around its center of mass and any further turning would depend on the rapid wastage of projections by fusion and combustion. There is, however, but little time, only a few seconds, at most, for readjustments of position to resistance encountered in the air. When there is little or no rotation, hollows or pits are dug in the forward side of a meteorite by the fierce air blast.

The Willamette meteorite is a good example of a mass escaping fracture and dissipation, and it shows in marked manner the hollows, pits and grooves on the forward side, that which is now turned away from the center of the hall."

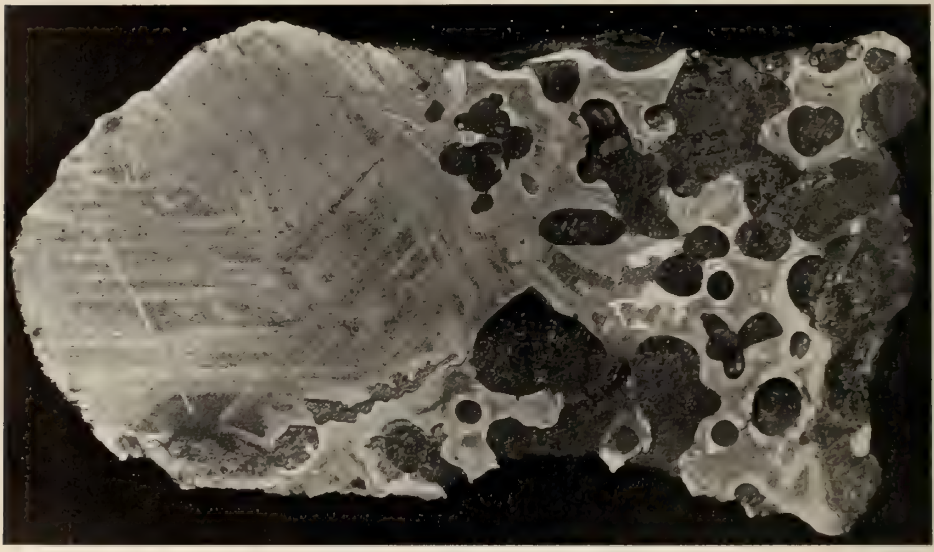
Another common mistake is that meteors pass, or fall, near the observer, when they are really miles away. A few years ago a fine meteor passed along the New England coast and observers south of Boston asserted that it dropped into the sea at the most a few miles distant; as a matter of fact it seems to have fallen far to the northward many miles from Cape Ann.

The death rate from meteorites is so low as to be negligible; while there have been a number of very narrow escapes there is but one death actually on record and that occurred in 1827, in India. Perhaps the narrowest of these escapes was when in 1847 a forty pound meteorite crashed into a room in Braunau in which three children were sleeping, covering them with dust and debris but leaving them unharmed.

The variety of objects sent to museums in the belief that they are meteors is astonishing, the most likely looking specimens usually proving to be pieces of furnace slag and the most unlikely including a "chunk" of cement which the sender declared had been seen to fall. Really very

few meteorites have been seen to fall and later on been recovered largely due to the point just noted that the distance of the fall is usually greatly underestimated.

Meteorites may be conveniently grouped in two classes, Siderites, or Iron Meteorites, and Aeorlites, or stony meteorites. A third class, known as Siderolites, has been made to include forms that consist of both stone and iron but this can hardly be defined since such masses vary

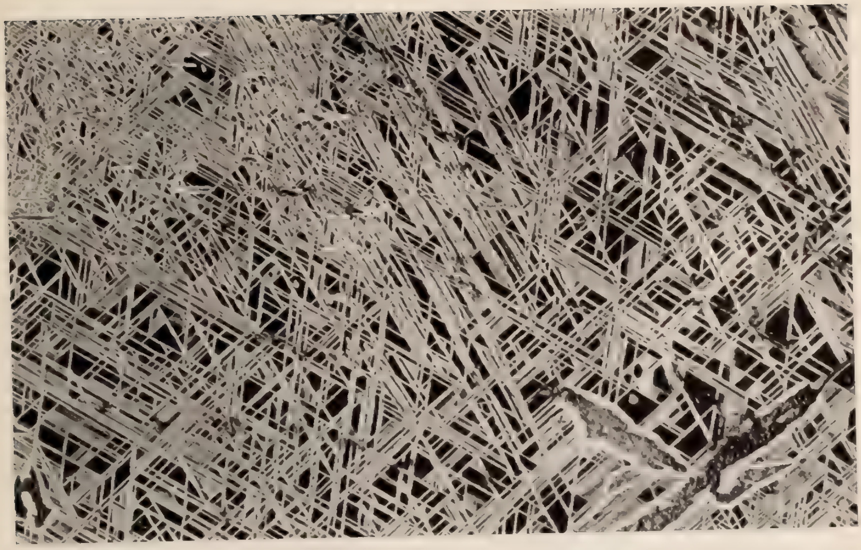


THE STRUCTURE OF METEORITES

A section of Brenham, siderite (nickle iron) on the left passing into siderolite (iron and stone) on the right. Note the broad Widmanstatten lines

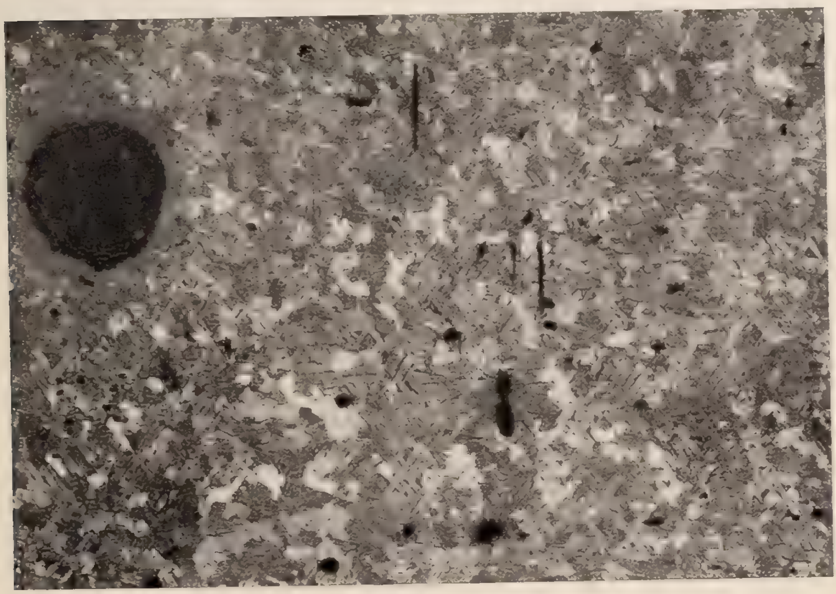
from almost pure iron to almost pure stone. An important constituent of iron meteorites is nickel found in varying quantities and giving rise to the curious Widmanstatten figures shown on sections of polished and etched meteorites. This name was given in honor of Alois von Widmanstatten who first noted these figures in 1808.

While meteoric iron is soft, it is extremely tough and difficult to cut so that sawing a section from a meteorite is a slow process. In the General Guide for 1914 and later it has been stated that the occurrence of nickel in meteorites led to the adoption of a nickel-iron alloy for the armor for battleships and as it is always difficult, and often impossible,



THE STRUCTURE OF METEORITES

Widmanstatten lines very clearly shown in a section of Carleton



THE STRTCTURE OF METEORITES

A section of Williamette showing its granular structure; the Widmanstatten lines are very faint

to find any authority for an "it is said" it may be well to note that this statement came from Mr. Edwin E. Howell, who had much to do with meteorites, and who told the writer he had been informed that the extraordinary toughness of a meteorite which had been sawn at the Navy Yard, Washington, and the knowledge that it contained nickel led to the trial and later adoption of the alloy for armour plate.

Meteorites seem not to have attracted the attention of collectors or of museums until a comparatively recent date: there is no mention of any in the cabinet of Sir Hans Sloane, nor in the earlier guides to the British Museum (1762–1763) which was based on his collection The great collections of the present day, having a combined representation of 820 falls, are to be found in five great museums, these in the order of their precedence being

Field Museum of Natural History (1925)	670 falls
British Museum (1922)	653 falls
Vienna Museum (1904)	560 falls
American Museum of Natural History (1925)	548 falls
U. S. National Museum (1925)	521 falls

The Field Museum owes its supremacy to the acquisition of the Ward-Coonley collection, brought together by Henry A. Ward who devoted many years of time and travel to gathering the largest private collection of meteorites ever made. In making this collection Professor Ward visited and described the Bacubirito Meteorite which according to him is even larger than Ahnighito having an estimated weight of 50 tons; however this has never been weighed and meteorites, like fish, are apt to lose in weighing, even Ahnighito, estimated at first to weigh 100 tons, and then at 50 shrank nearly 14 tons, when placed on the scales and we suspect that should Bacubirito be tried in the balance it would be found wanting a number of the 50 tons ascribed to it. It required the labor of twenty-seven men to fully expose Bacubirito and it was then found that it rested on the solid rock, having apparently fallen before the soil had formed. The measurements of this great iron are 13′ 1″ long 6′ 4″ by 5′ 4″. Ahnighito and Bacubirito shrink into insignificanc compared with the iron reported to have been found in 1921 in the desert of Adrar, near Chinguetti, Mauretania. This is said to be 300 feet in length, but as yet the report has not been verified. Another of Professor Ward's acquisitions was a piece of the Vermian iron preserved at Teheran, Persia. How to cut a piece from this was something of a problem; the arsenal at Teheran was equipped with a planer, but no

motor and the deficiency was supplied by running the planer back and forth by man power for several days.

The U. S. National Museum has labored under the handicap of limited appropriations and a belief that the national institution should pay more for a given object than any other, a belief that allowed these "others" to acquire various specimens at much less than the price

TUCSON

An iron meteorite weighing 1400 pounds in the collection of the United States National Museum

originally asked. It is pleasant to record that of late years there is a growing recognition that, after all, the museum is a National institution and it is becoming more and more the recipient of valuable gifts.

So much for meteorites in general. A few words about some of the more remarkable specimens in the Museum Collections are now in order. The American Museum of Natural History is the fortunate possessor of the largest meteorite so far discovered (Ahnighito) and the largest, as well as the most interesting, found in the United States—(Willamette). It

AHNIGHITO

The largest known meteorite, weight $36\frac{1}{2}$ tons, brought from Greenland by Peary in 1897. Called the Tent by the Eskimo, christened Ahnighito by Marie Ahnighito Peary. Presented, together with the Woman and Dog by Mrs. Morris K. Jesup, 1905

THE WOMAN

One of the Cape York irons, weight 3000 pounds. In spite of the fact that she was guarded by the dog, the Eskimo pounded off fragments from which to make knives

also has a fine representation of the Canyon Diablo, popularly famous for containing diamonds, and a portion of the Long Island, Kansas, unique for showing a movement in the mass before it fell; so its collection may well claim to stand first as regards quality. The larger, more striking meteorites are displayed in Memorial Hall, the smaller, including many choice examples showing structure, are at present installed in the North Corridor, near the Auditorium.

Ahnighito, chief among meteorites, lay for many years on an island in Melville Bay, Greenland, and was secured by Peary in 1897 after

unsuccessful attempts in the previous two years: the last of these, fortunately, left the "great iron" near the water's edge, on a rocky ledge that served as a pier. How it was finally placed aboard the "Hope," how the "Hope" smashed her way through the ice out of Melville Bay, and struggled through a gale to the lee of Wolstenholm Island where the meteorite was lowered to a position of greater safety is graphically told

THE DOG

One of the Cape York Meteorites weight 1100 pounds. For centuries the Dog stood watch over the woman on an island in Melville Bay, Greenland.

by Peary in "Northward Over the Great Ice." How it was christened Ahnighito by Marie Ahnighito Peary, then not quite a year old, just as the meteorite started on its last journey is also told by Mrs. Peary in "The Snow Baby." So much bad weather attended the efforts to remove the big meteorite that it is small wonder that not only the Eskimo, but even some of the sailors regarded it with superstitious awe, but the spell was finally broken and no evil has accompanied it to its present resting place.

Associated with Ahnighito, which was known to the Eskimo as the Tent, though a few miles distant, were the smaller Dog and Woman, brought away by Peary in 1896, and now shown in its company.

Collectively these were appropriately called Saviksue, the great irons; and pieces of the Woman were laboriously hammered off by the Eskimo for knives, the worn out hammer stones accumulated about it testifying to the time and patience expended in obtaining a few bits of the precious metal.

WILLAMETTE IN TRANSIT

Willamette, is not only the most extraordinary in appearance of any meteorite, and the largest that has been found in the United States but of interest for the struggle for its possession. It was found by two prospectors in the autumn of 1902 about 19 miles south of Portland on the land of the Portland Land Company. Having discovered that this was a meteorite one of the prospectors, who lived about three quarters of a mile away, fashioned a rough but strong carriage to which with great skill and much labor he transferred the big mass of iron and with no other aid than that of his son, a horse, and a simple windlass, moved the meteo-

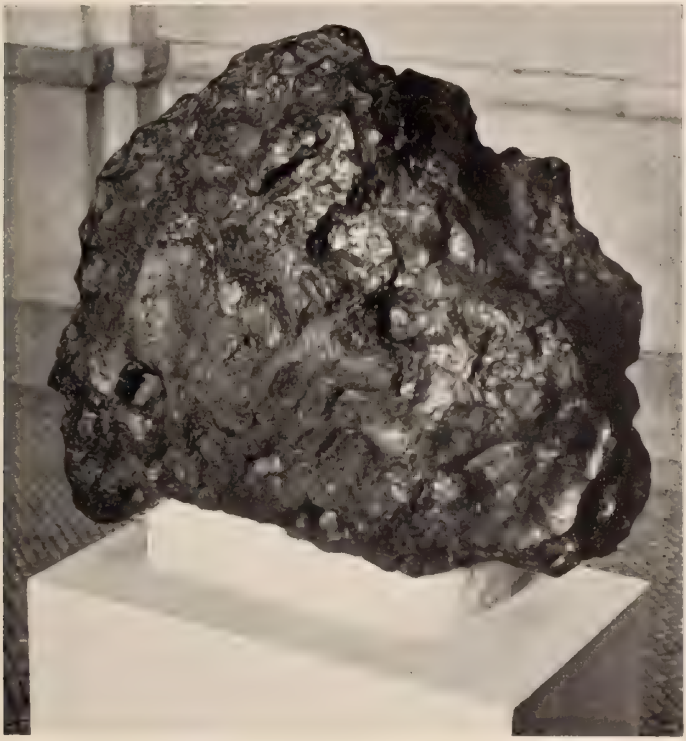
rite to his own grounds. This took three months of hard work, for the ground was soft, and the meteorite heavy, the best days work covered only fifty yards and sometimes the car was moved only fifteen feet.

When the Portland Land Company learned of their loss, and such a remarkable find could not be long unknown, they naturally entered suit for the recovery of their property and ultimately secured it, to the disappointment of Professor Ward who had hoped to make the Willamette the crowning glory of his collection. Instead, by the generosity of

FOREST CITY

Mrs. William E. Dodge it now rests in the American Museum of Natural History where it arouses the interest of every visitor and where its history is daily read by many visitors. It is indeed remarkable, first for its size; it is ten feet long, and weighs fifteen and one half tons; and next for its appearance, being—on one side—deeply pitted with great hollows, large enough to hold a child. These are due to rusting as it lay in the ground, decomposition beginning with masses of troilite, one of the minerals peculiar to meteorites. The side next the wall is worn and slightly hollowed by the burning away of the surface as the meteor sped through the air.

Forest City is one of the few meteorites whose history is definitely known. As recorded by Dr. Hovey "On Friday, May 2, 1890, at 5:15 p.m. a brilliant ball of fire shot across the sky from west to east in northern Iowa, its flight being accompanied by a noise likened to that of heavy cannonading or of thunder, and by scintillations like those of fireworks.



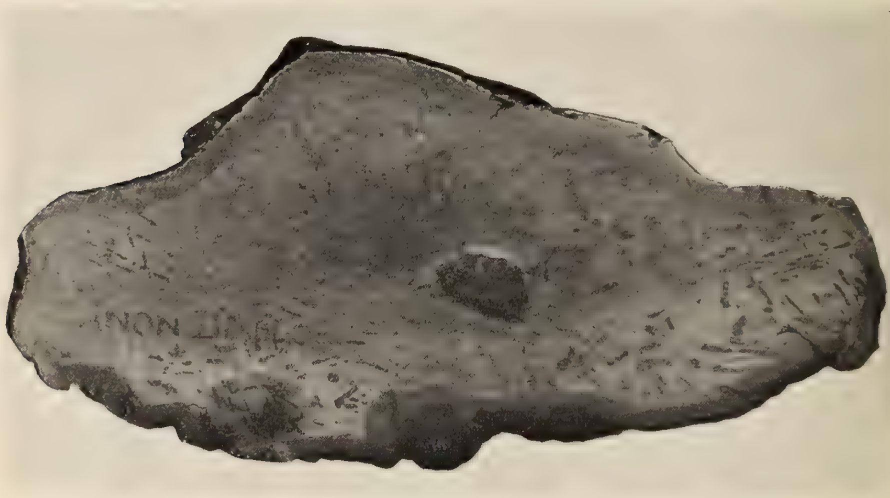
CANYON DIABLO

A meteorite that contained minute diamonds; only one other similar specimen is known.

The meteoric light was dazzling even in the full daylight prevailing at the time and the noises, which were due to explosions, were heard throughout a district 200 miles in diameter. This meteor was the Forest City Meteorite. It burst when it was about 11 miles northeast of Forest City, Winnebago County, and the fragments, more than a thousand of which have been recovered, were scattered over an area about a mile wide and two miles long. Some of the pieces, each of which is a perfect little

meteorite, weigh as much as several pounds, but most of them are from a twentieth of an ounce up to twenty ounces. The largest fragment is that shown which weighs 75 pounds.

HOLBROOK, a stony meteorite, is one of those that fell in a shower of fragments, 2000 of which are in the collection of the American Museum of Natural History: they range in size from $\frac{1}{90}$ of an ounce up of $14\frac{2}{3}$ pounds and have a collective weight of 485 pounds. The fall took place on July 12. 1912.



SECTION OF CANYON DIABLO
A diamond was found in the black spot.

CANYON DIABLO has already been noted, but it may be added that the diamonds it contains are mostly of minute or microscopic size and that it costs many, many times their value to recover them.

LONG ISLAND, found in Phillips County, Kansas, is noteworthy in several respects: in the first place it is unique in showing by its markings that some of the fragments into which it burst moved upon one another just before it fell; had it exploded when some distance above the earth these markings would have been burned away leaving the usual crust of oxide. That it broke to pieces just before it struck is apparent because the 3000 pieces that have been recovered, having a combined weight of 1244 pounds, were found in a space of fifteen by twenty feet, the most compact "shower" known. It is also unique as being, in its total weight, the largest stony meteorite so far discovered.

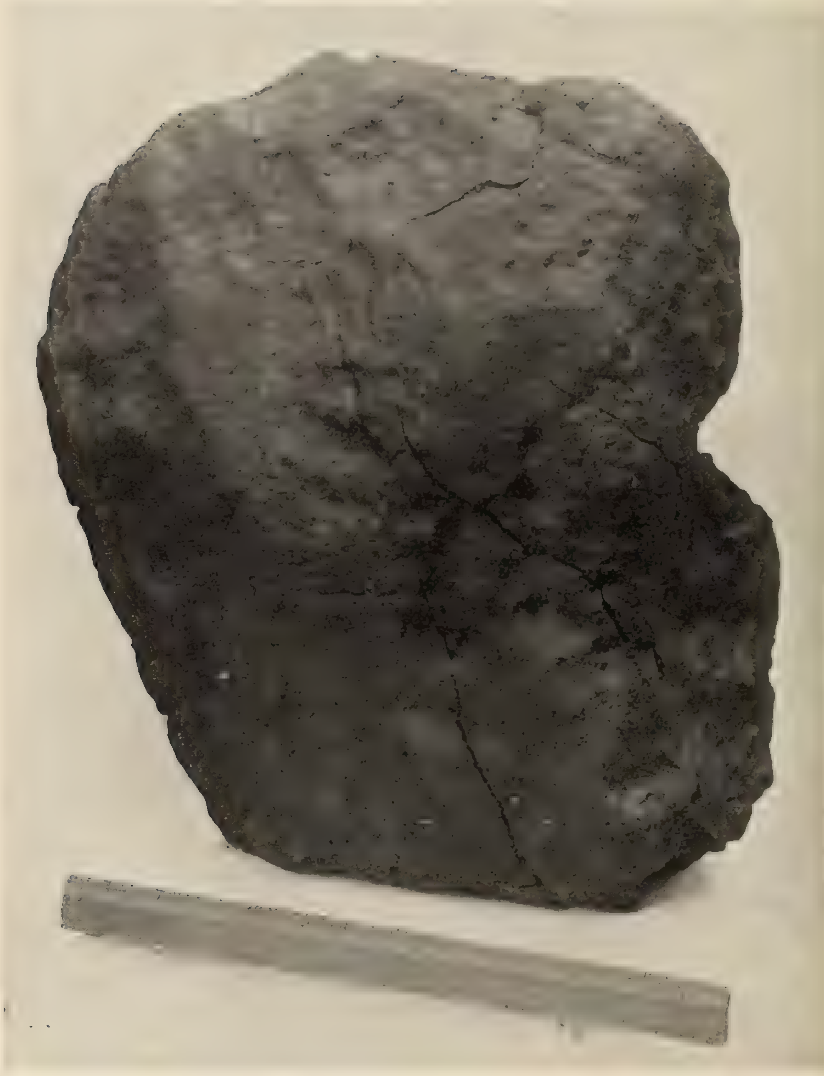
Selma, a stony meteorite from Alabama, is believed to have fallen on July 20, 1898, though it was not found until March, 1906, the delay in its discovery being largely due to the fact that, as usually happens, it fell much further from the observers than it was supposed to have done. If

LONG ISLAND

The diagonal markings show that the fragments rubbed on one another just before they struck the earth.

Long Island is collectively the largest stony meteorite, Selma, weighing 300 pounds, is the heaviest single stone in the United States, the largest known being a stone of the Knyahina fall, weighing 645 pounds, now in the British Museum.

These are the larger meteorites or those of more popular interest, but the hundreds of smaller specimens are important for the student



SELMA

Weight 306 pounds, the largest entire stony meteorite—aerolite—in the United States

though aside from the time and place of their fall it requires careful chemical analysis and the aid of the microscope to gather the information they contain.

A catalogue of the collection giving the weight, classification, locality, date of fall when known, references to literature and other details has been prepared by Dr. Reeds and is now (1926) ready for publication. The collection includes meteorites from the countries, states and islands noted in the following list compiled by E. J. Foyles.

METEORITE LOCALITY LIST

- Alaska
- Algeria
- Anatolia
- Arabia
- Argentina
- Australia
- Austria
- Azerbaijan
- Belgium
- Bolivia
- Brazil
- British Columbia
- Chile
- Colombia
- Corsica
- Costa Rica
- Czecho-Slovakia
- Denmark
- East Africa
- Ellesmereland
- England
- Esthonia
- Finland
- France
- French West Africa
- Germany
- Greece
- Greenland
- Guatemala
- Hawaiian Islands
- Holland
- Honduras
- Hungary
- India
- Ireland
- Italian Somaliland
- Italy
- Jamaica
- Japan
- Java
- Latvia
- Mauritius
- Mexico
- New South Wales
- New Zealand
- Norway
- Ontario
- Persia
- Poland
- Portugal
- Queensland
- Rumania
- Russia
- Saskatchewan
- Siberia
- South Africa
- Spain
- Sweden
- Syria
- Turkestan
- United States
  - Alabama
  - Arizona
  - Arkansas
  - California
  - Colorado
  - Connecticut
  - Georgia
  - Idaho
  - Indiana
  - Iowa
  - Kansas
  - Kentucky
  - Maine
  - Maryland
  - Michigan
  - Minnesota
  - Mississippi
  - Missouri
  - Montana
  - Nebraska
  - Nevada
  - New Jersey
  - New Mexico
  - New York
  - North Carolina
  - North Dakota
  - Ohio
  - Oklahoma
  - Oregon
  - Pennsylvania
  - South Carolina
  - South Dakota
  - Tennessee
  - Texas
  - Virginia
  - West Virginia
  - Wisconsin
  - Wyoming
- Victoria
- West Africa
- West Australia
- Yugo-Slavia

And here it may be well to say that the market prices for meteorites, save for those of exceptional size, are by no means so great as their finders sometimes suppose. They have never appealed to the private collector so there is no keen competition for their possession, as there is for eggs of the Great Auk, to "boost" prices.

Finally—any day, or night, a meteorite may fall in your back yard, though the chances are many millions against it.